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Bateman et al.

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(54) **SYSTEMS AND METHODS FOR A BATHING SYSTEM**

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A47K 3/02 (2006.01)

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CPC ***A47K 3/001*** (2013.01); ***A47K 3/02*** (2013.01)

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USPC 4/560.1
See application file for complete search history.

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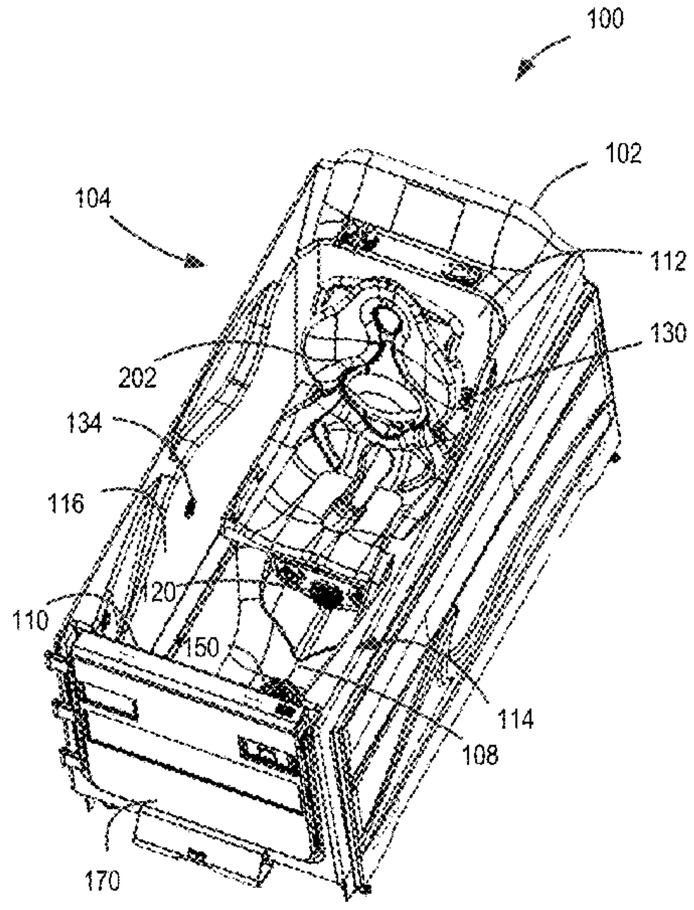
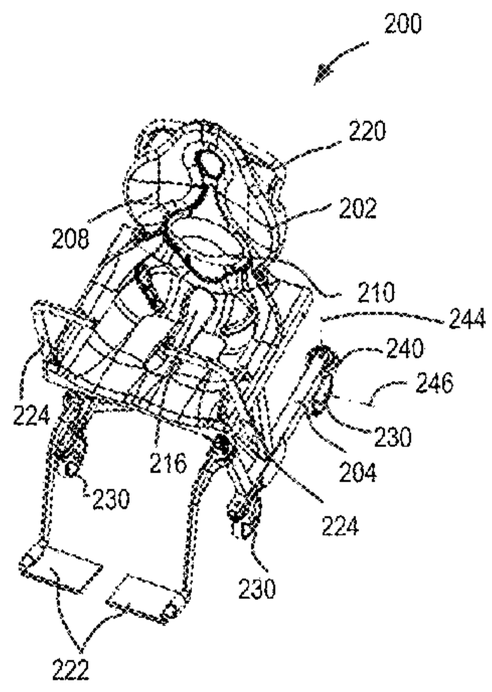
(57) **ABSTRACT**

A bathing system, includes a transfer system having a carrier base and a transfer seat. A sliding of the transfer seat relative to the carrier base may facilitate transfer of the transfer seat toward or away from the tub. A first arm and a second arm of the carrier base extends into and overlaps with a first support surface and a second support surface of the tub respectively. A controller may be in operative communication with a plurality of sensors and determine whether the bathing system is in a state where it is permissible to transfer the transfer seat toward or away from the tub and if so, actuate components of the transfer system to permit the transfer of a patient in the transfer system.

20 Claims, 13 Drawing Sheets





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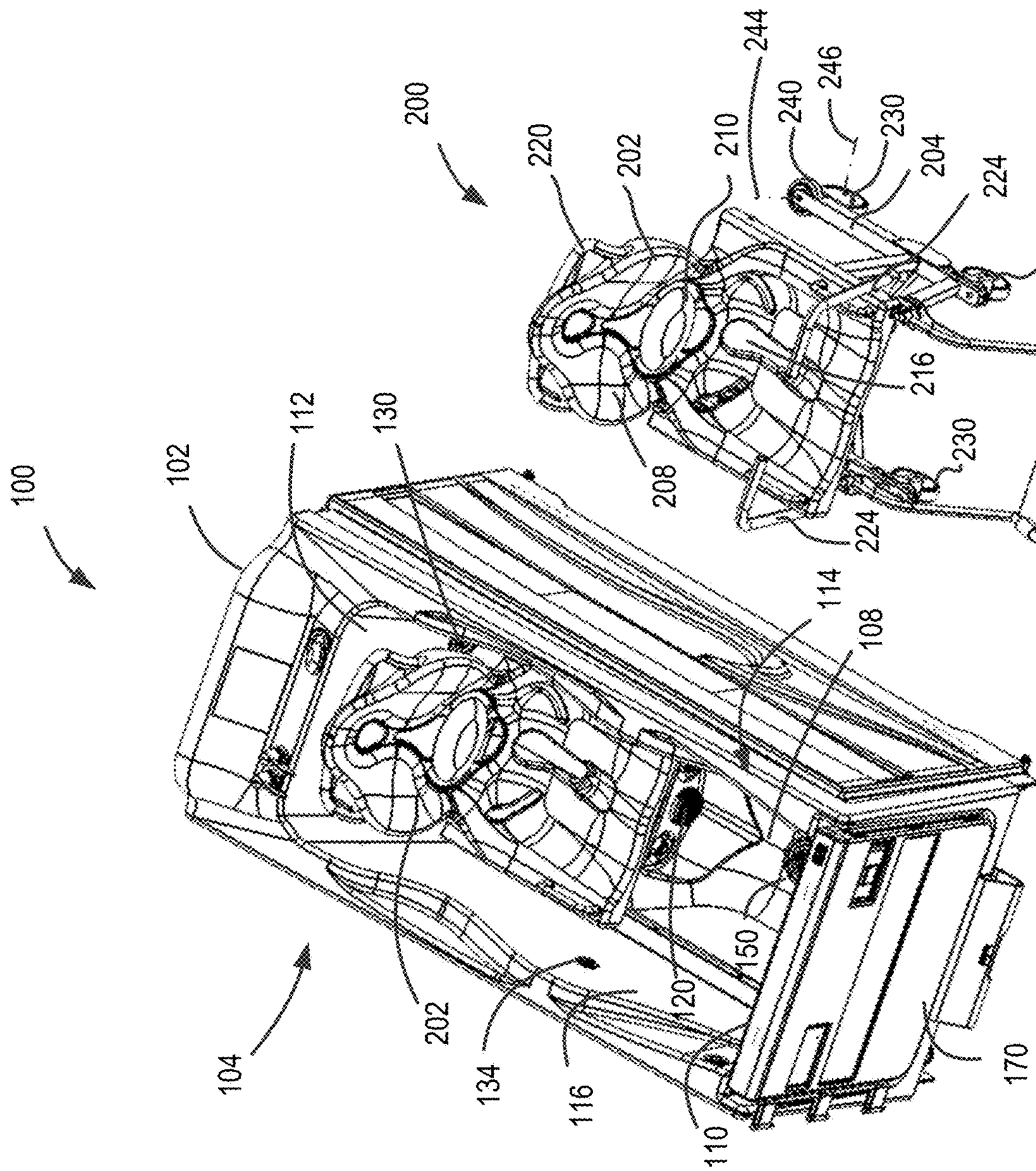
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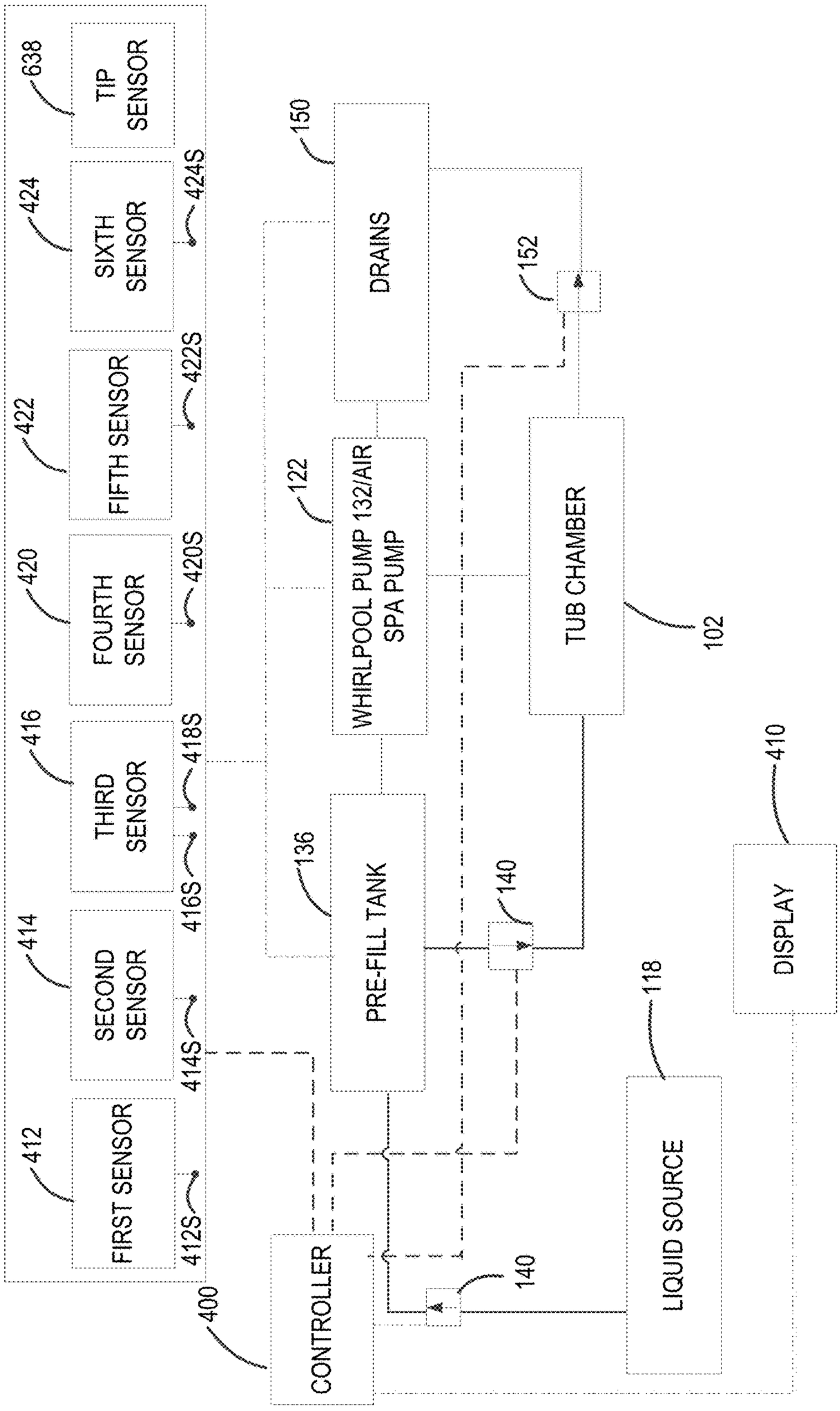
FIG. 1A

FIG. 1B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SIXTH SENSOR
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422
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422S
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418S
416S
414
SECOND SENSOR
414S
412
FIRST SENSOR
412S
400
CONTROLLER
150
DRAINS
152
122
WHIRLPOOL PUMP 132/AIR SPA PUMP
136
PRE-FILL TANK
140
TUB CHAMBER
102
410
DISPLAY
118
LIQUID SOURCE
140

FIG. 1C

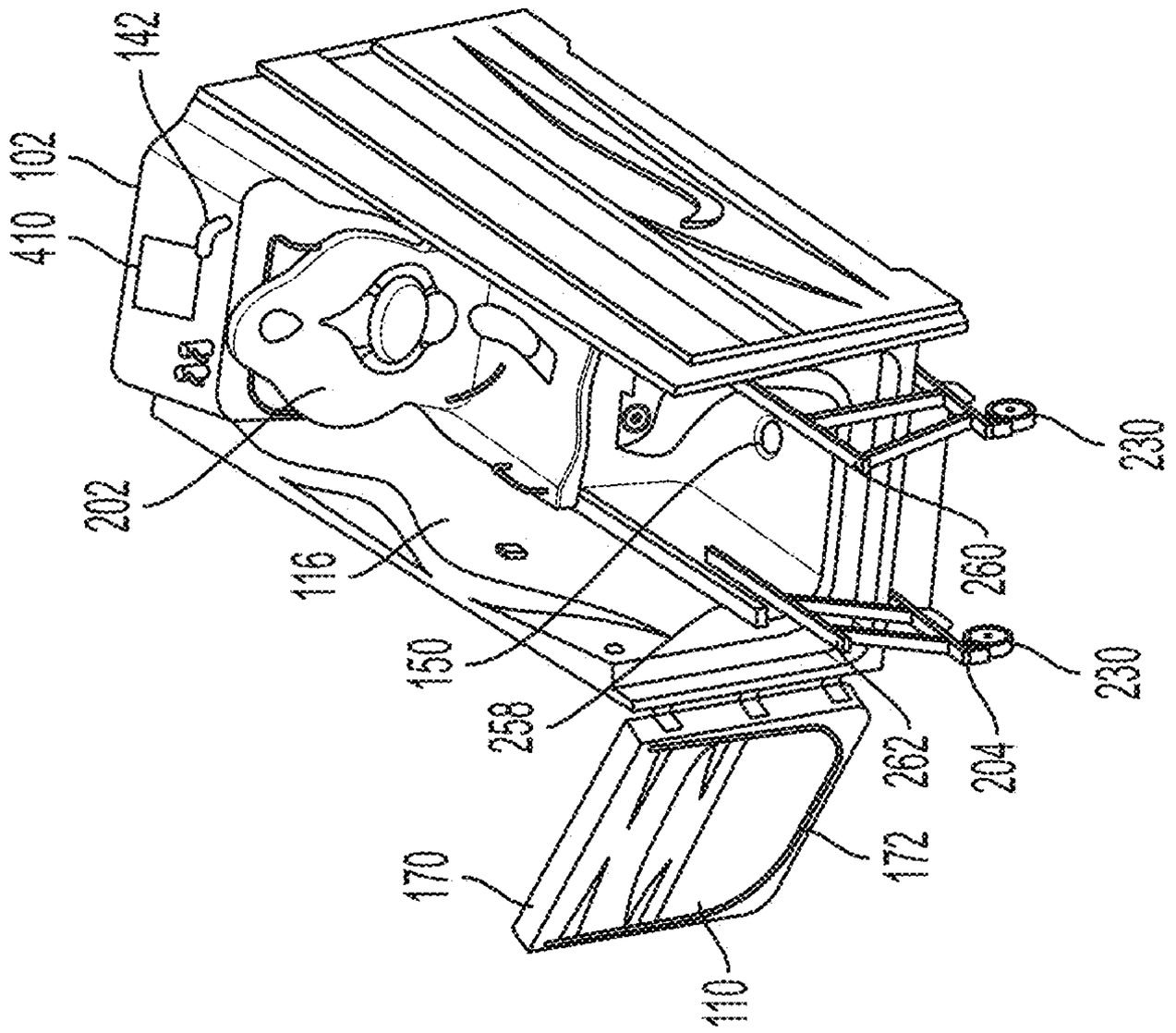
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FIG. 3

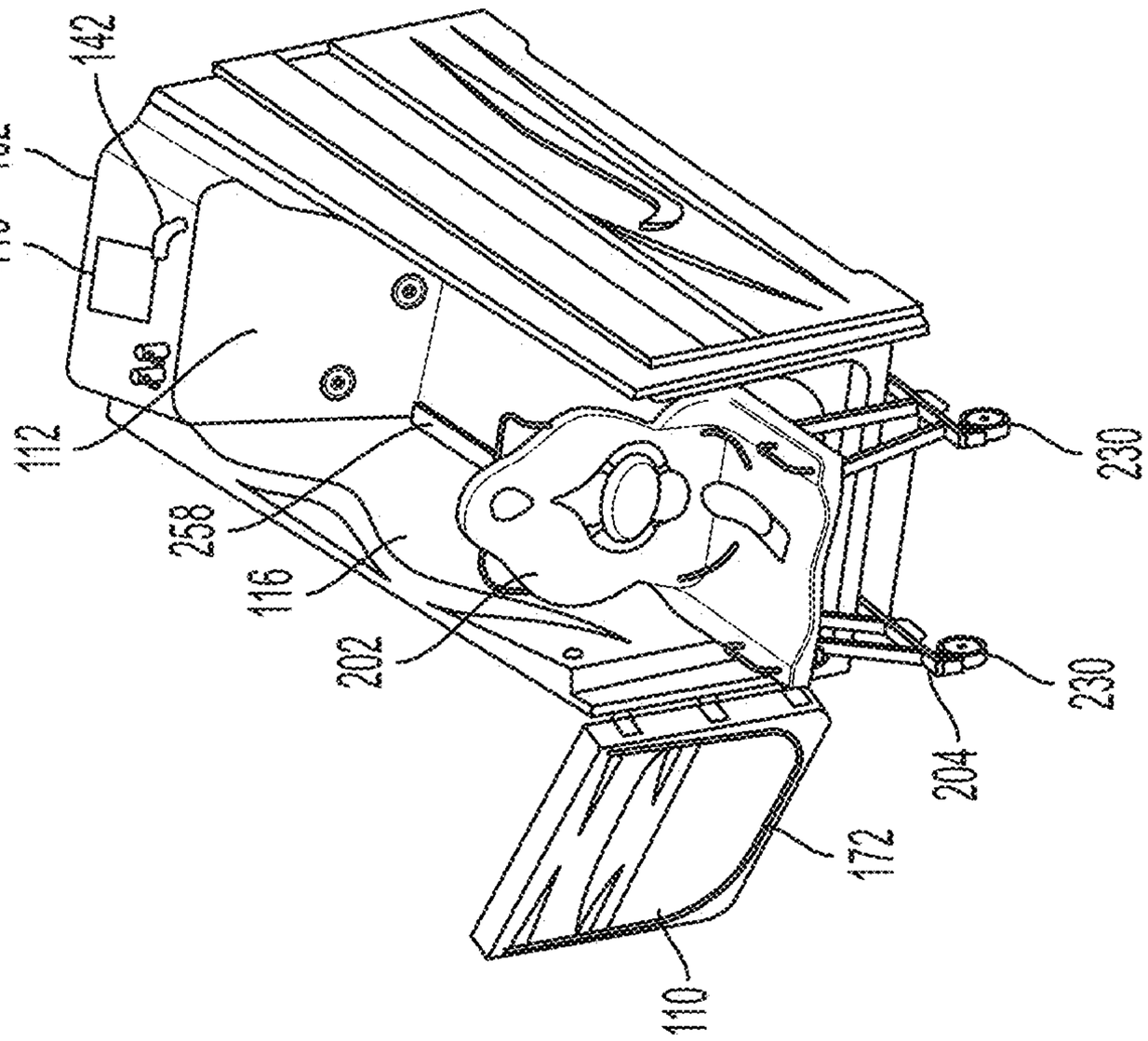
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FIG. 2

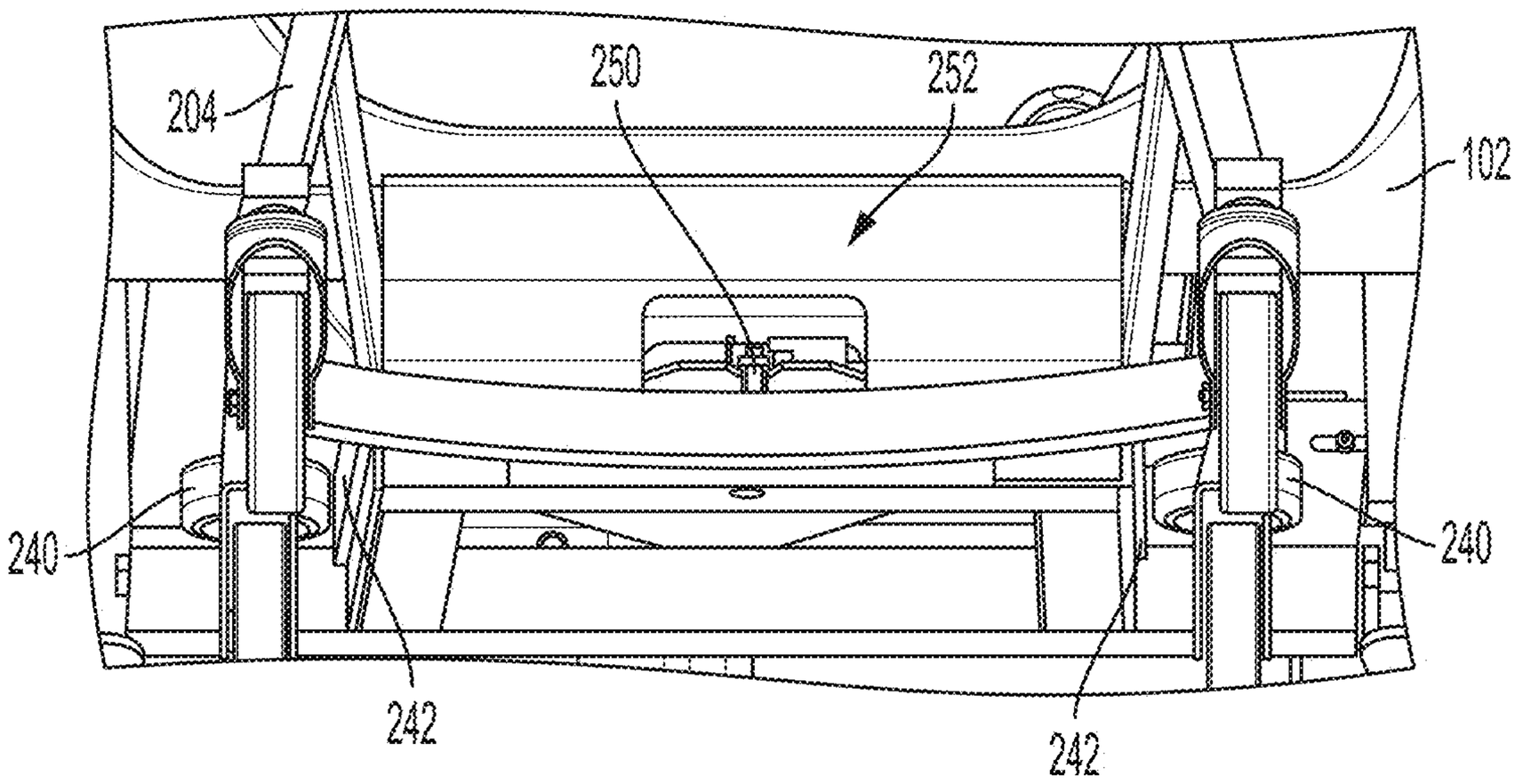


FIG. 4A

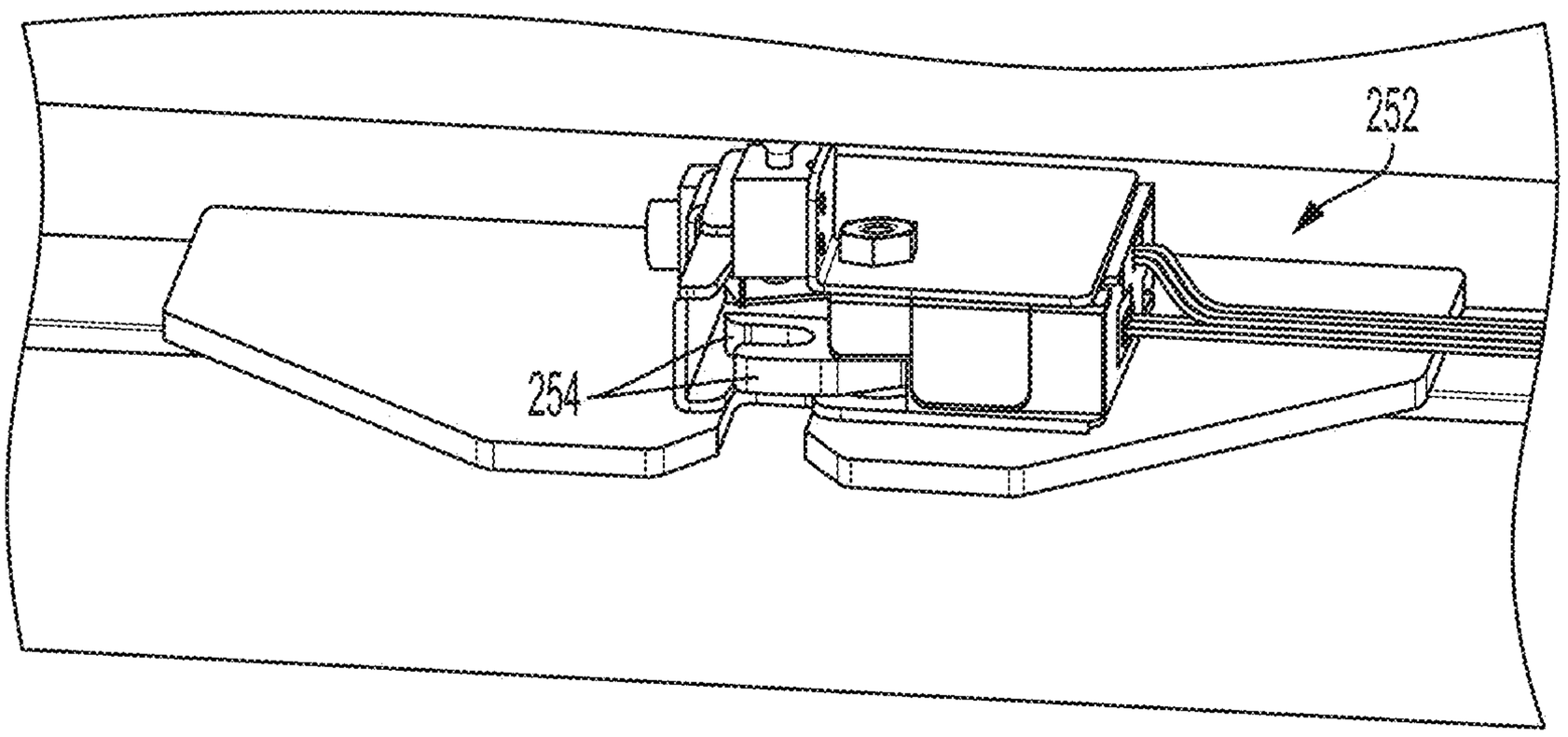


FIG. 4B

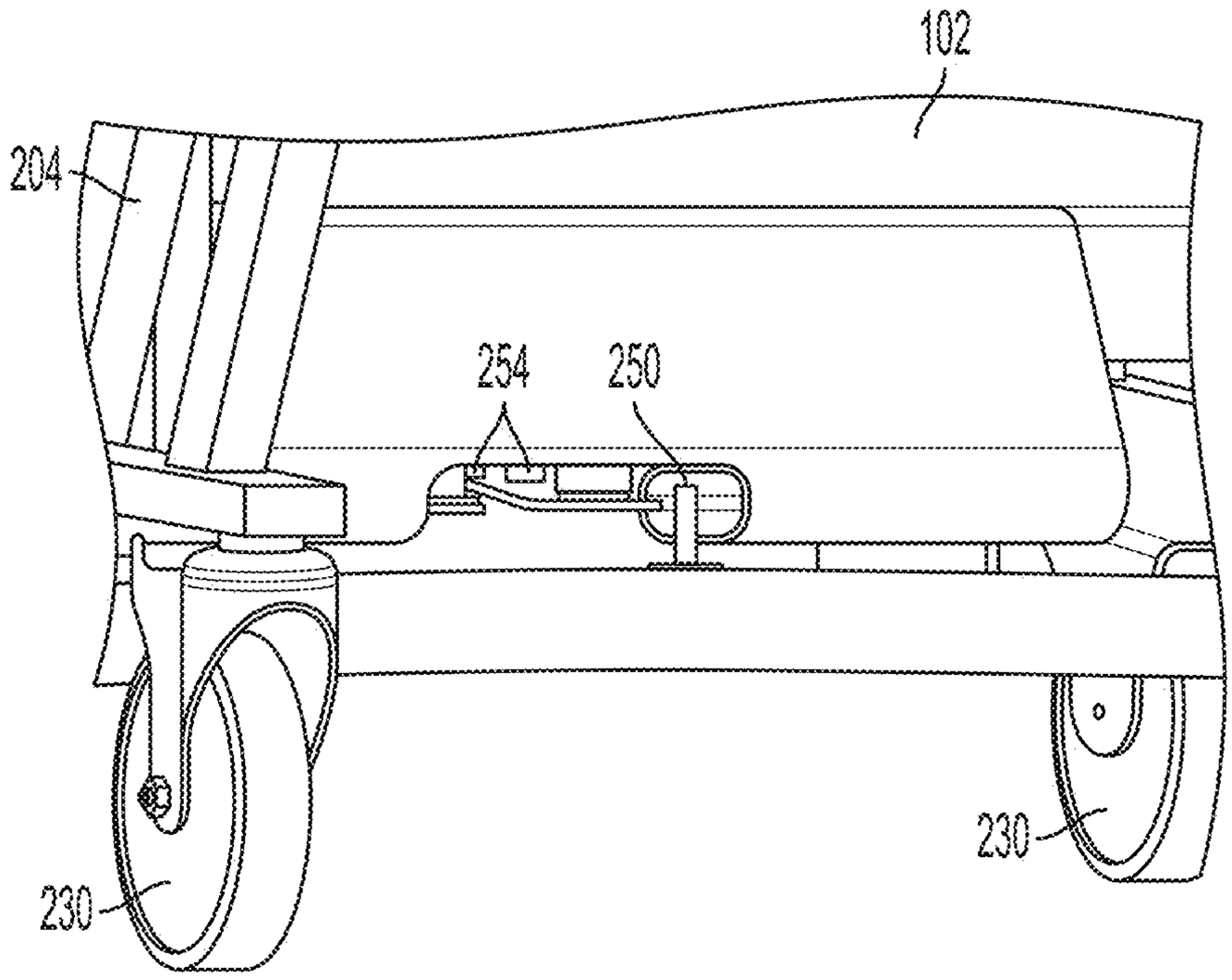
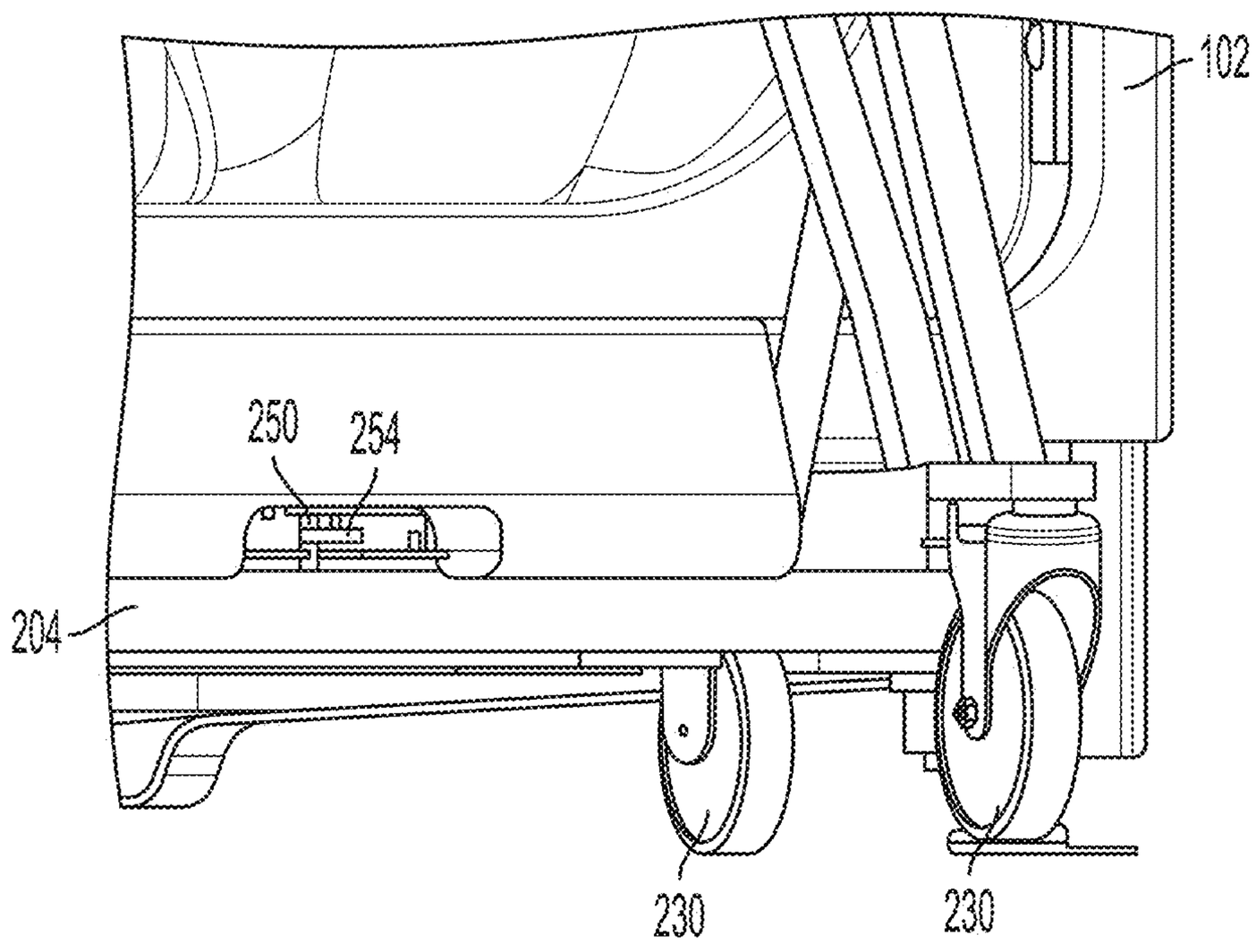


FIG. 5



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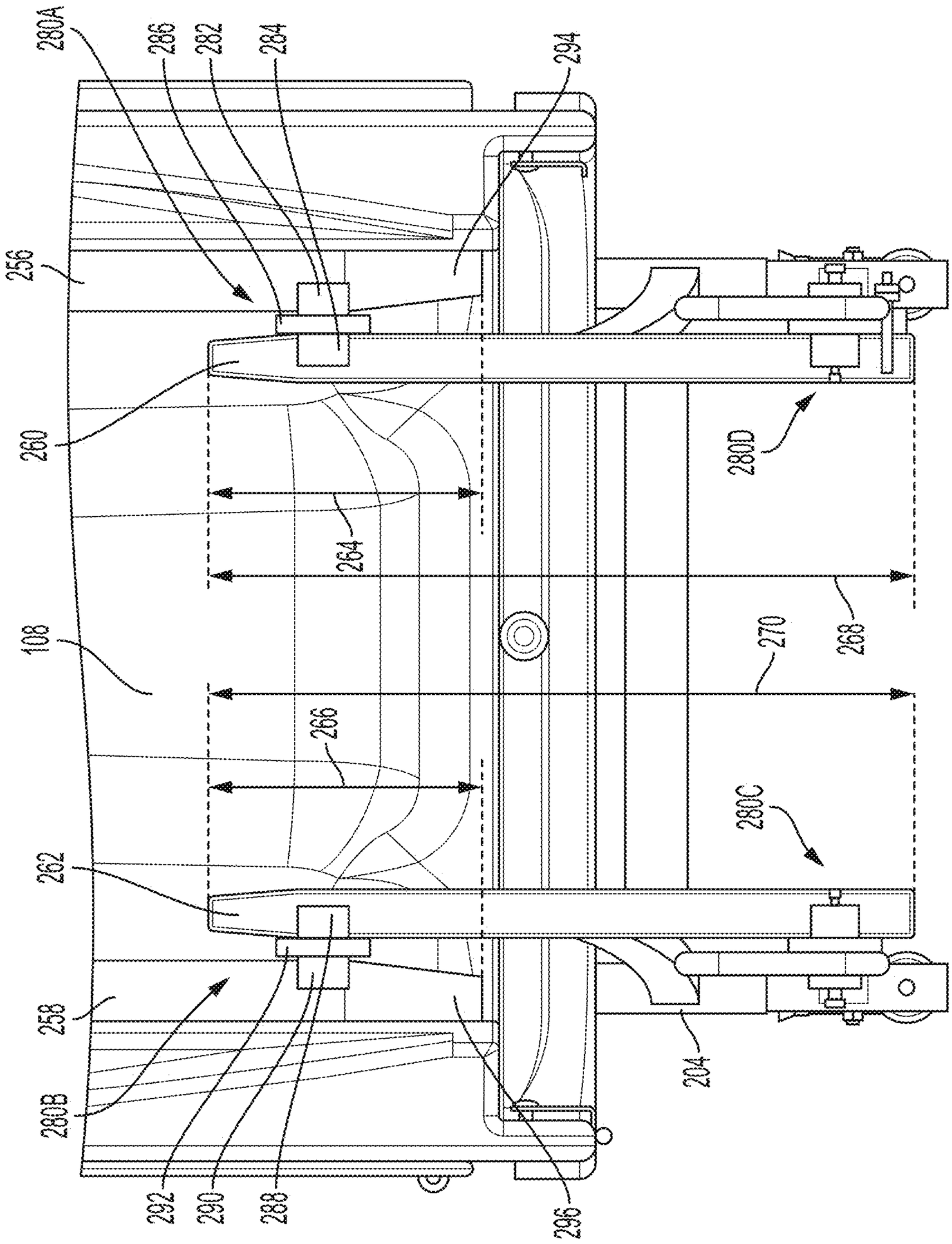
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FIG. 7

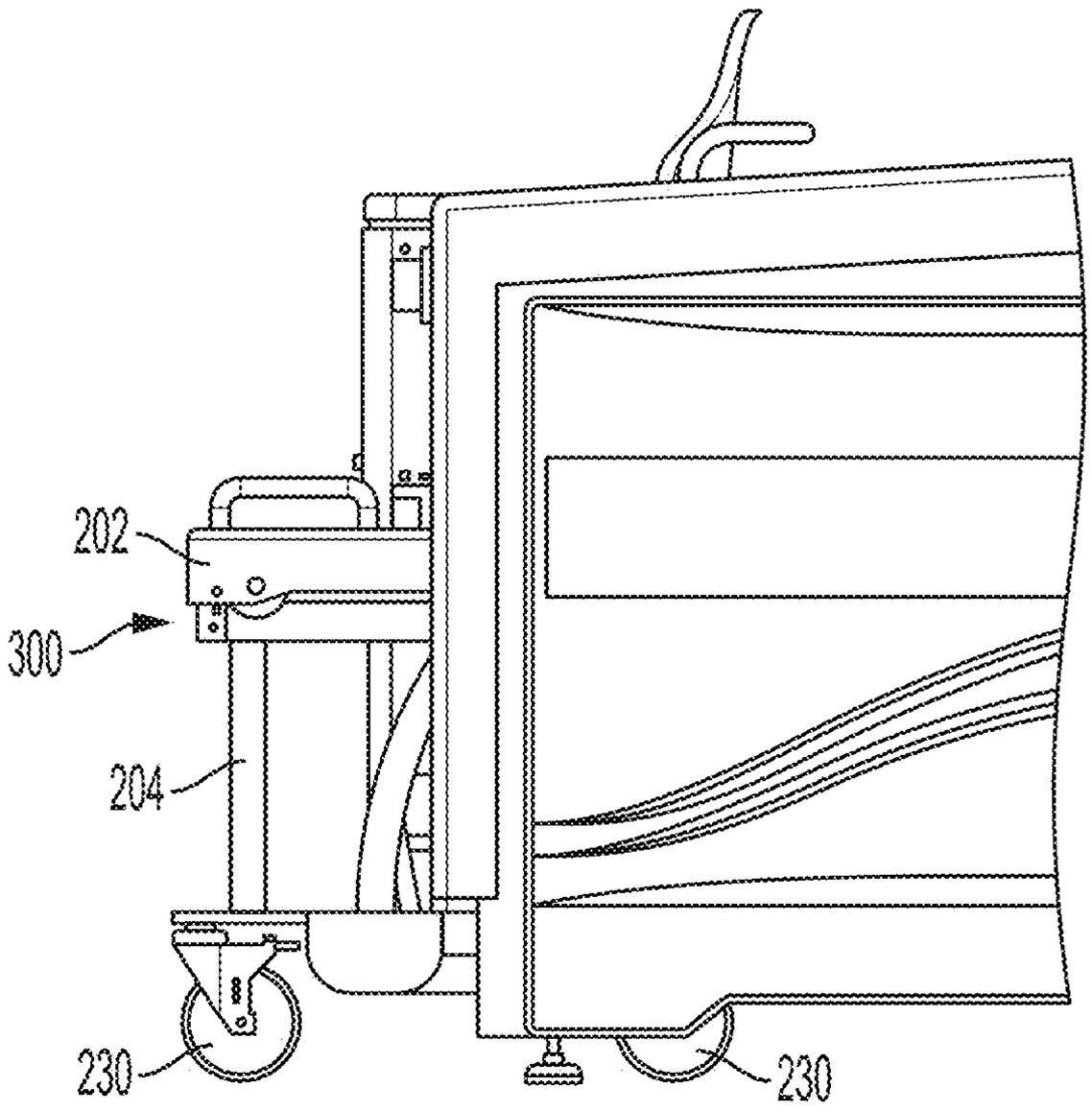
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FIG. 8

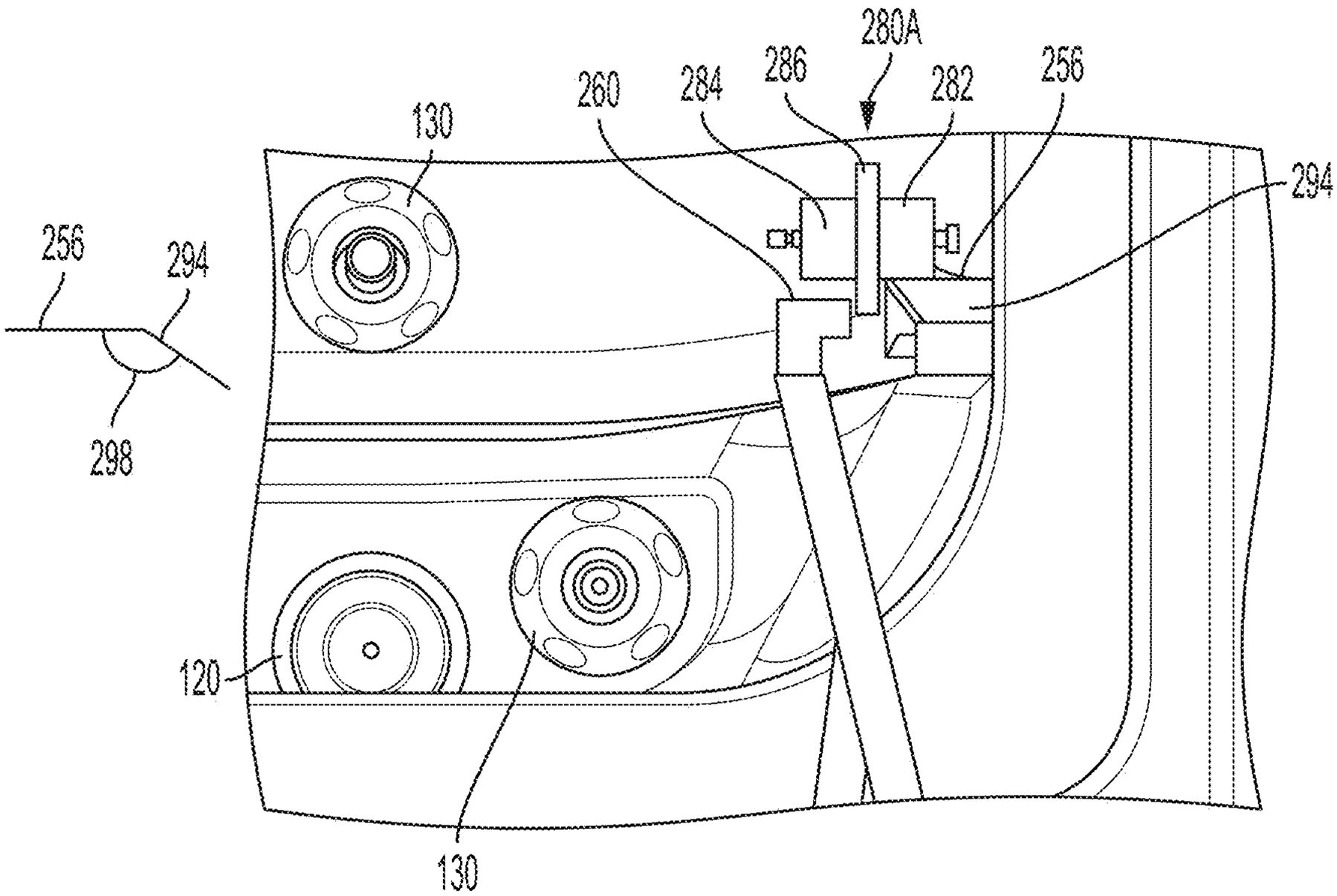
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FIG. 9

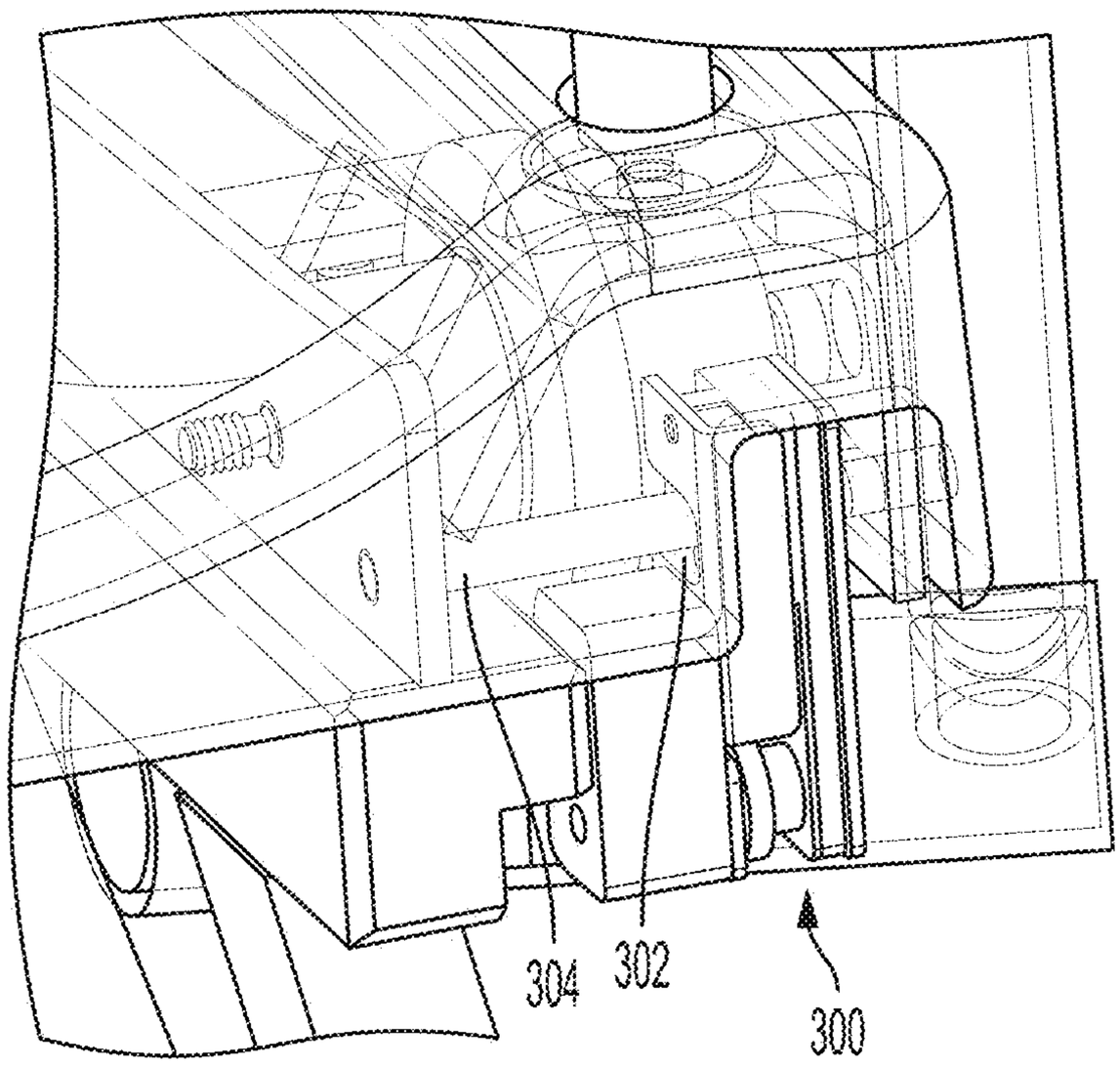
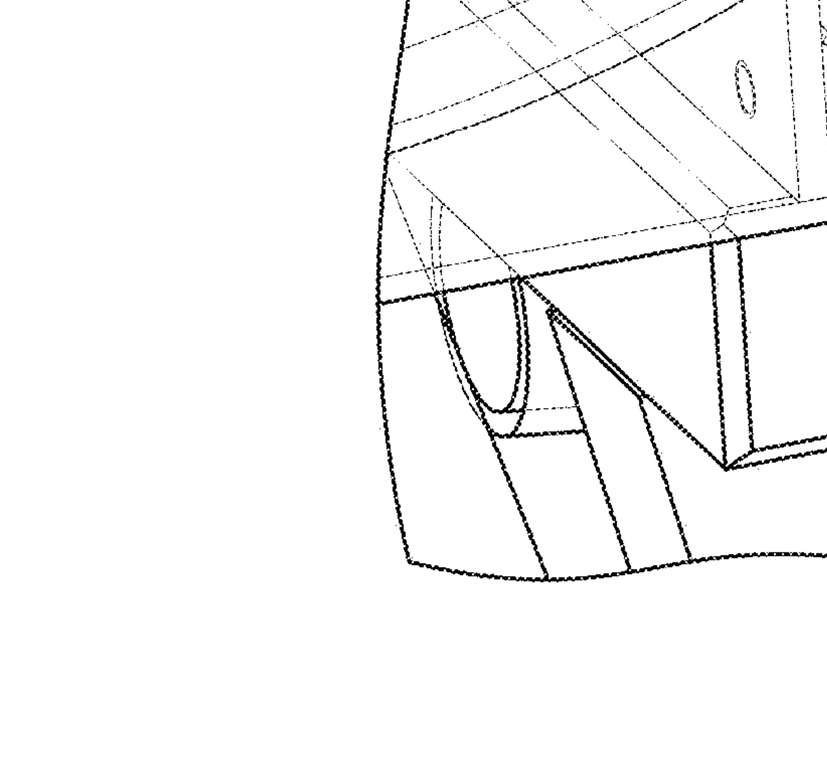


FIG. 10



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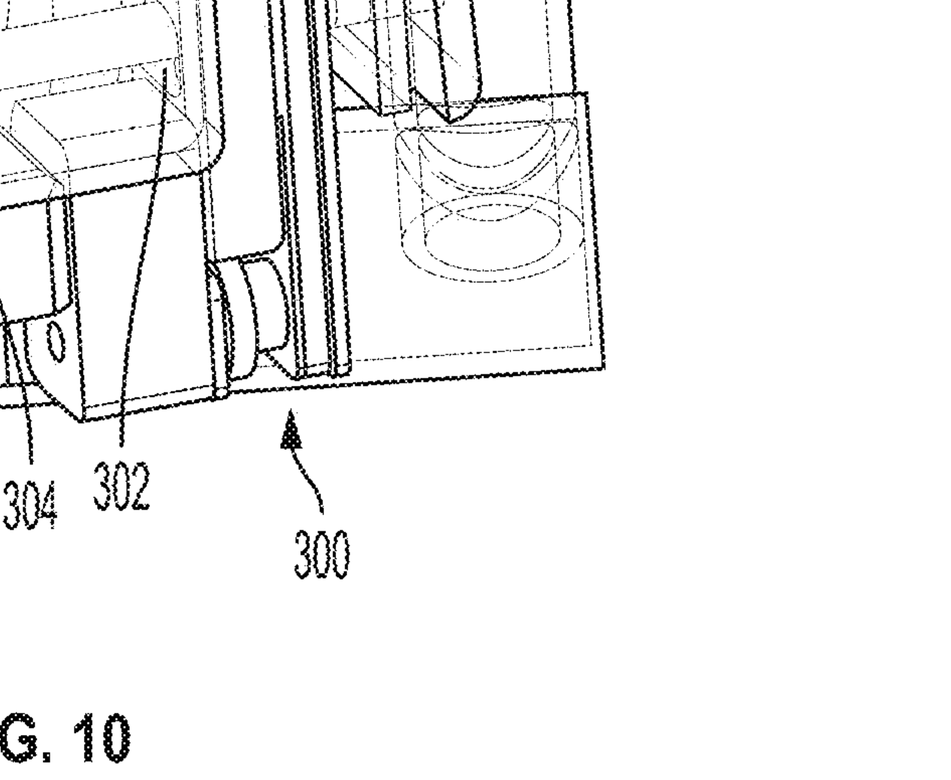

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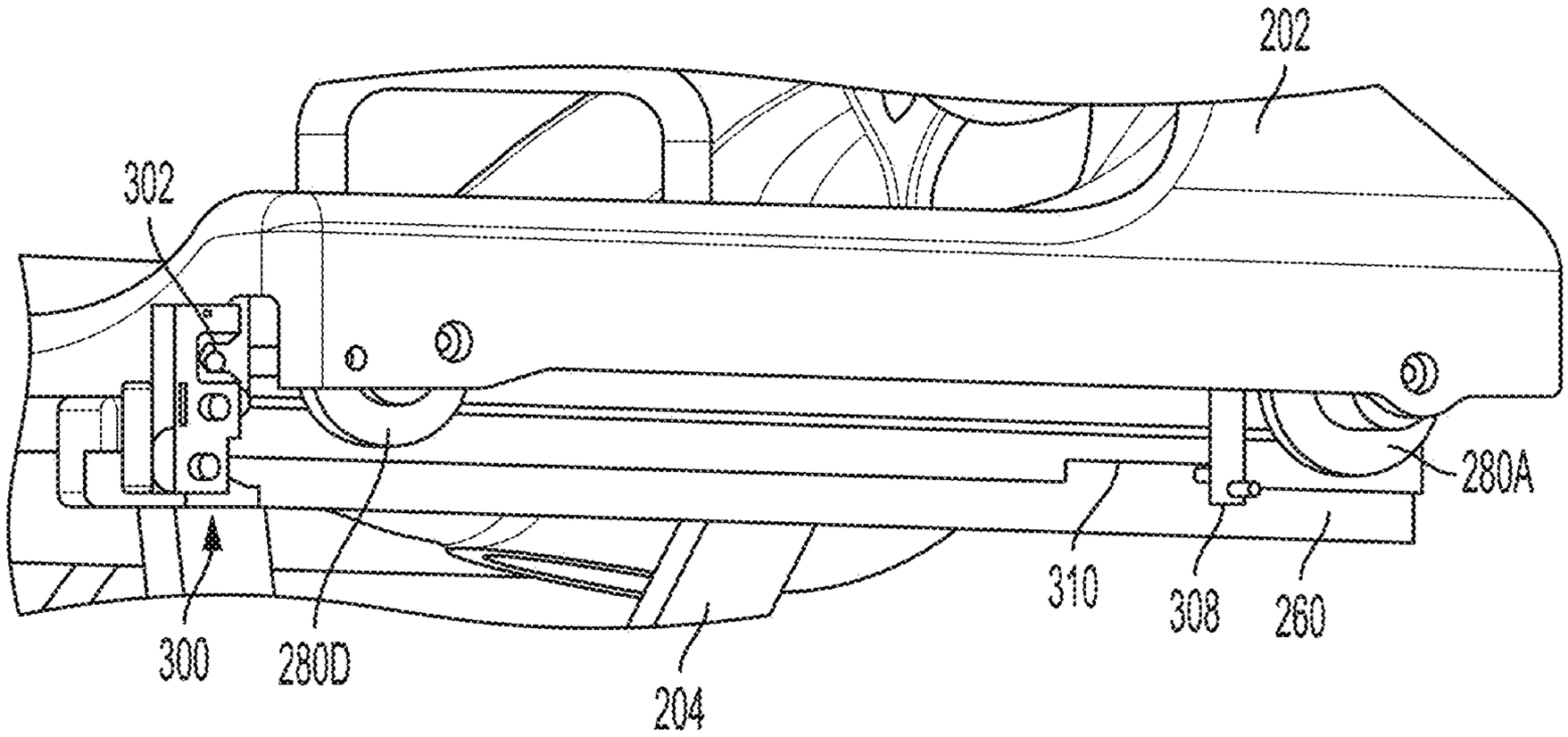
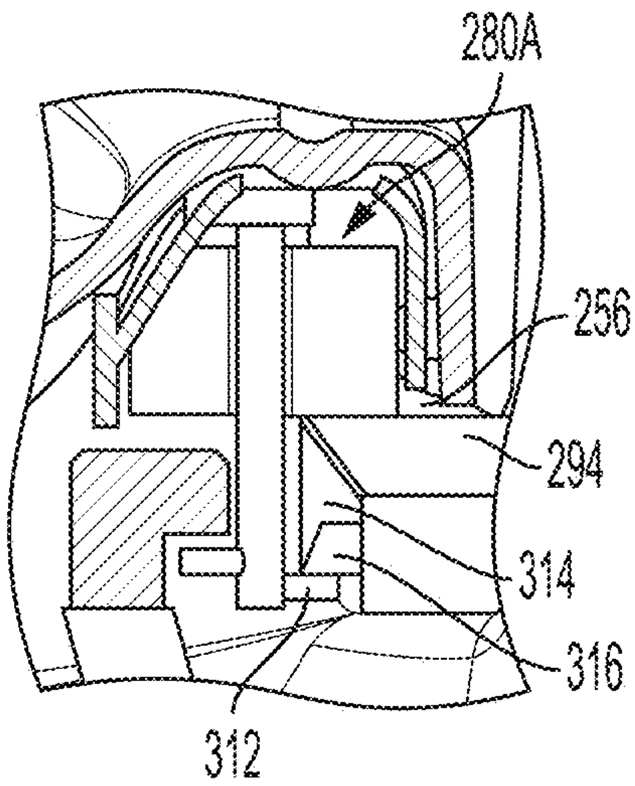


FIG. 13



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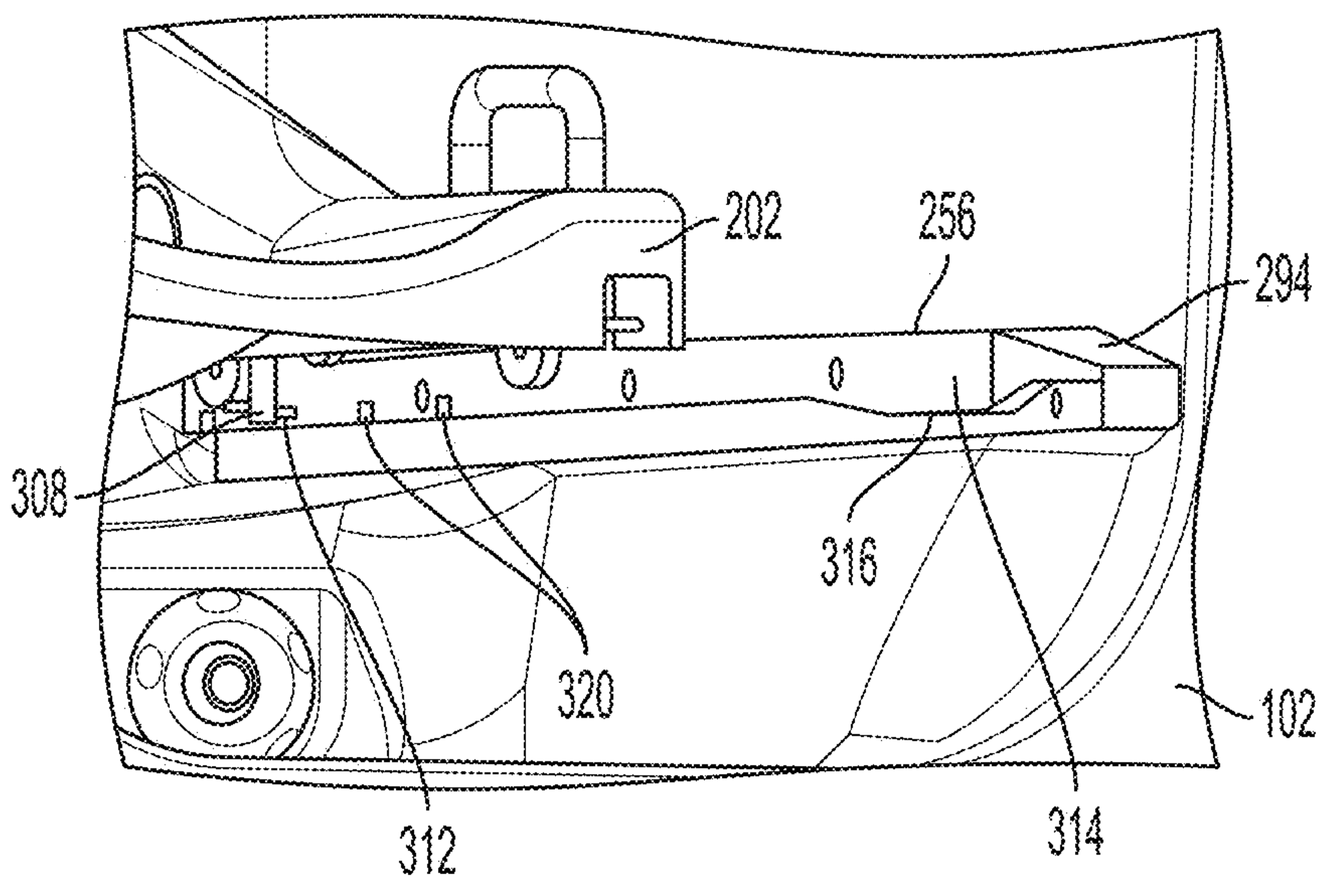
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FIG. 15

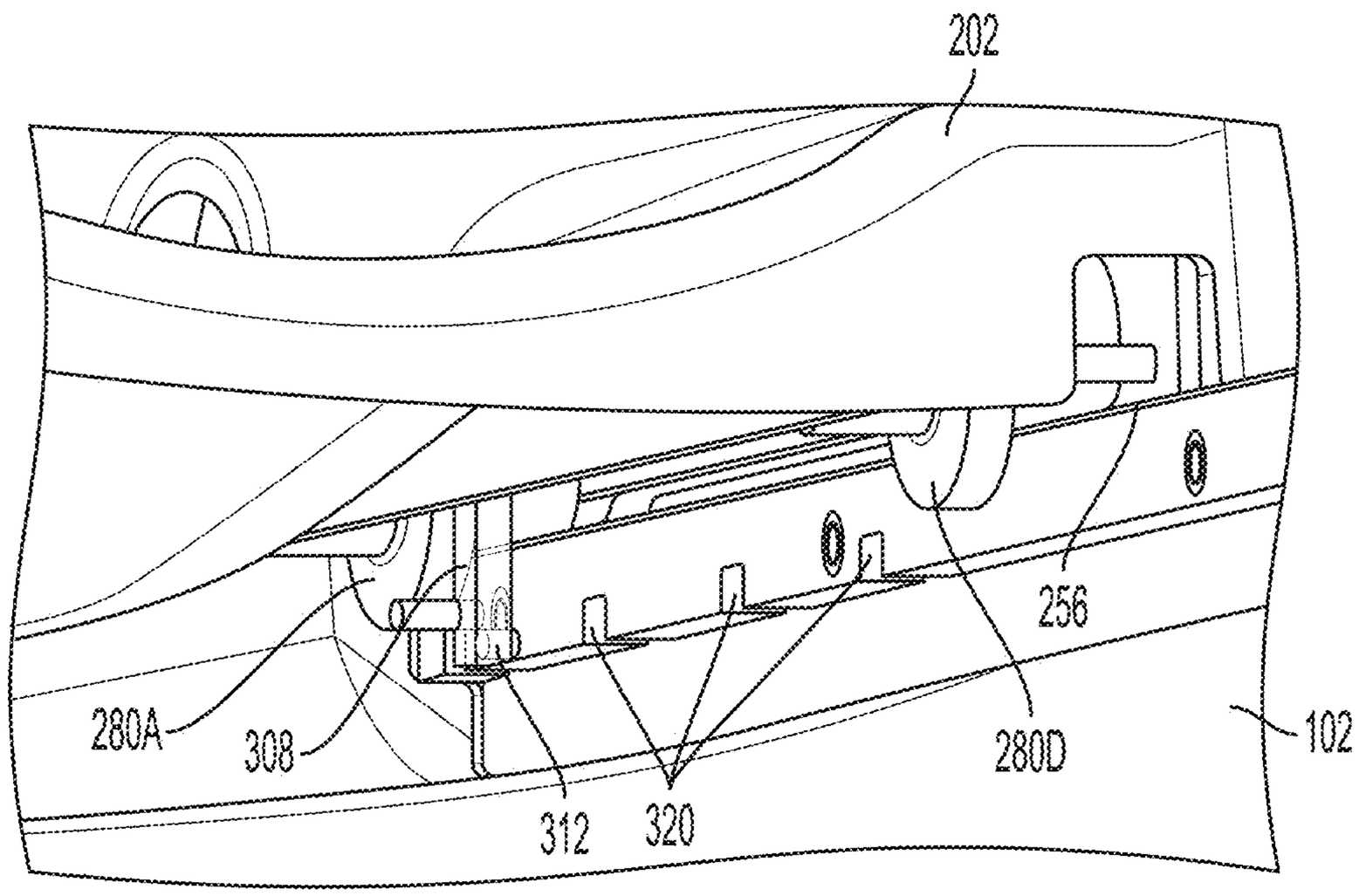
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FIG. 16

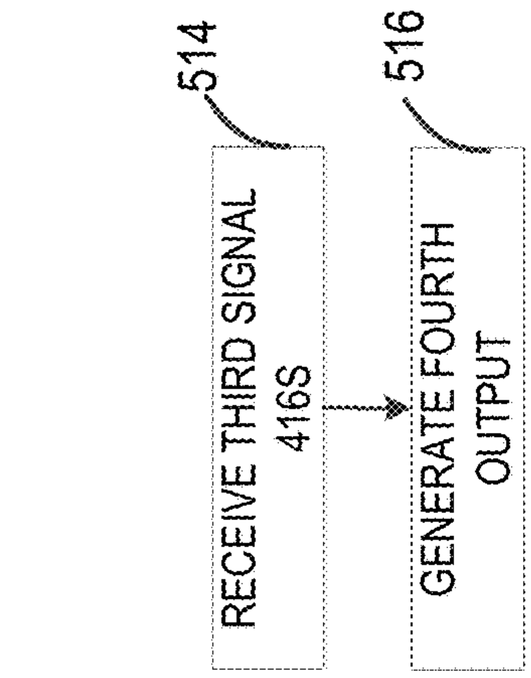

FIG. 17B

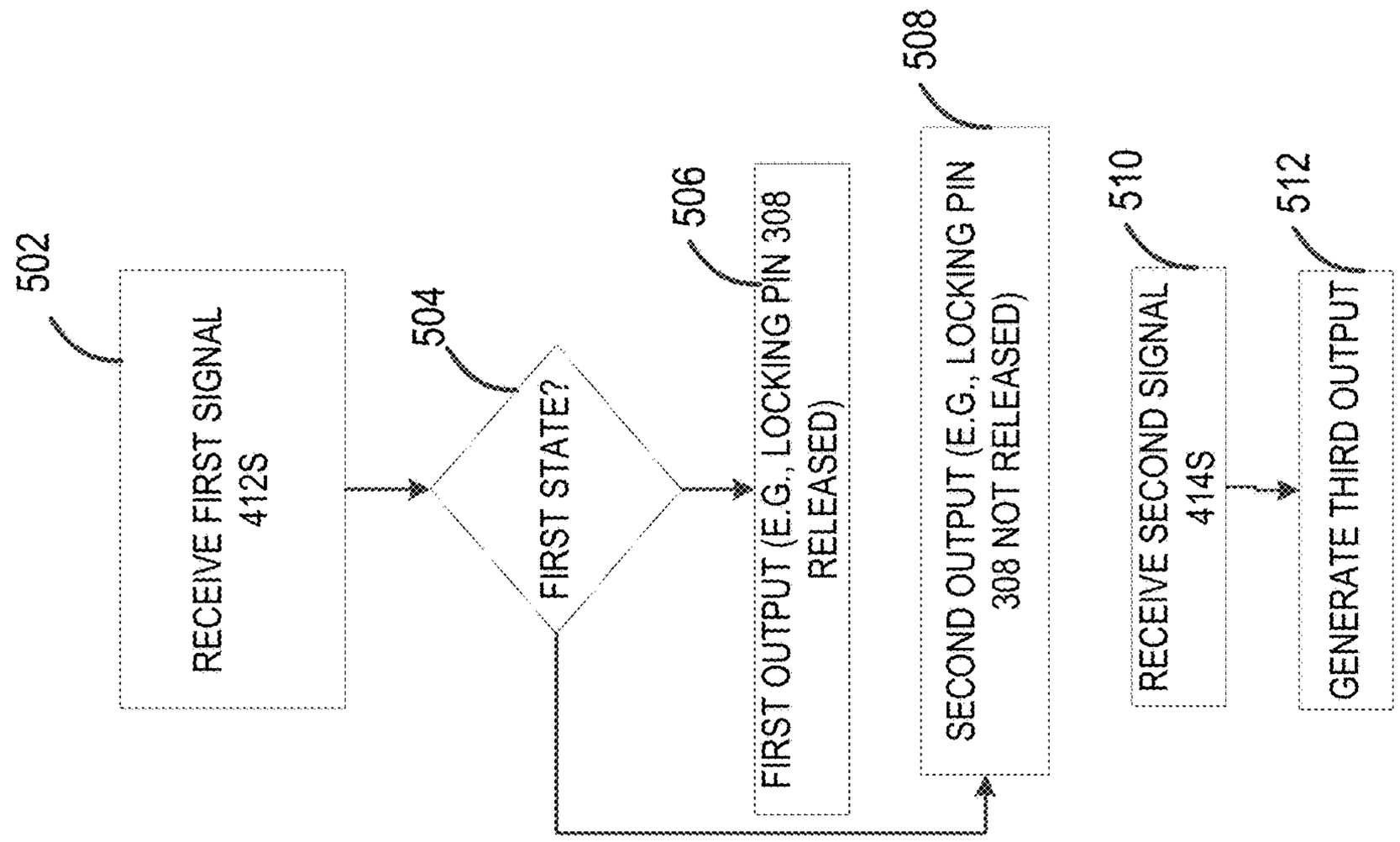

FIG. 17A

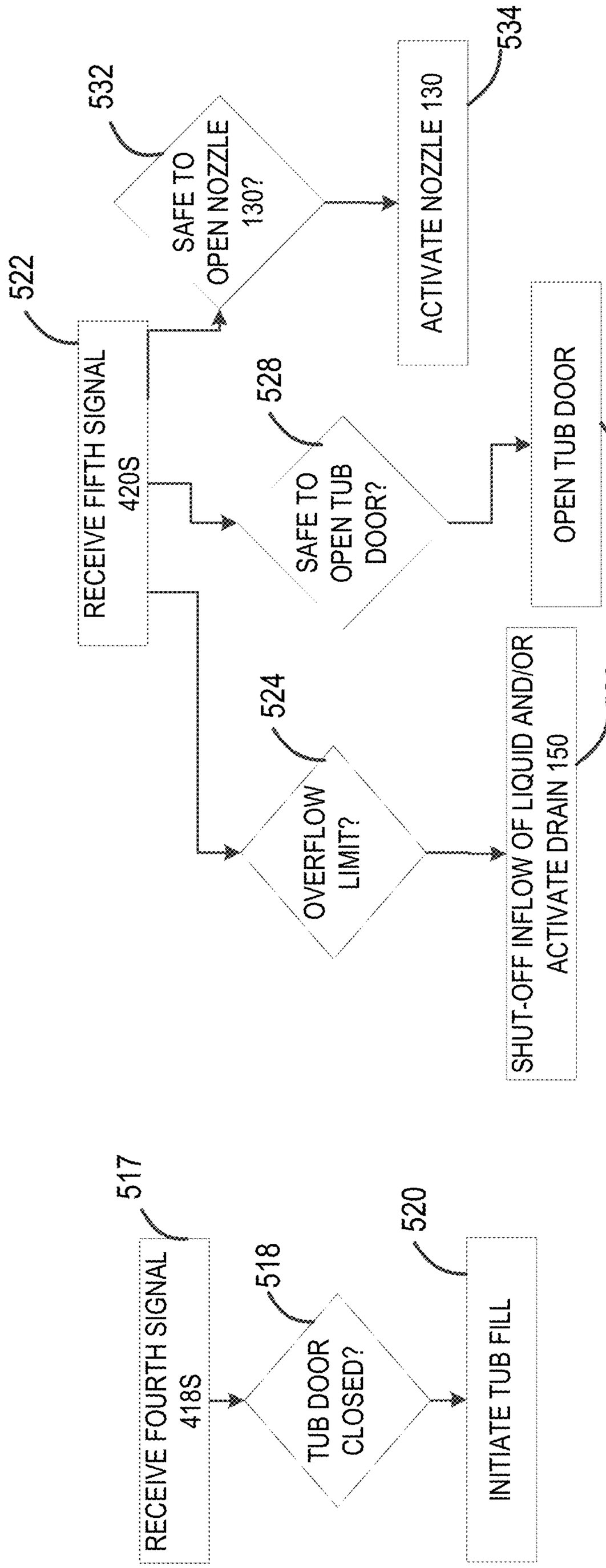

FIG. 17D

FIG. 17C

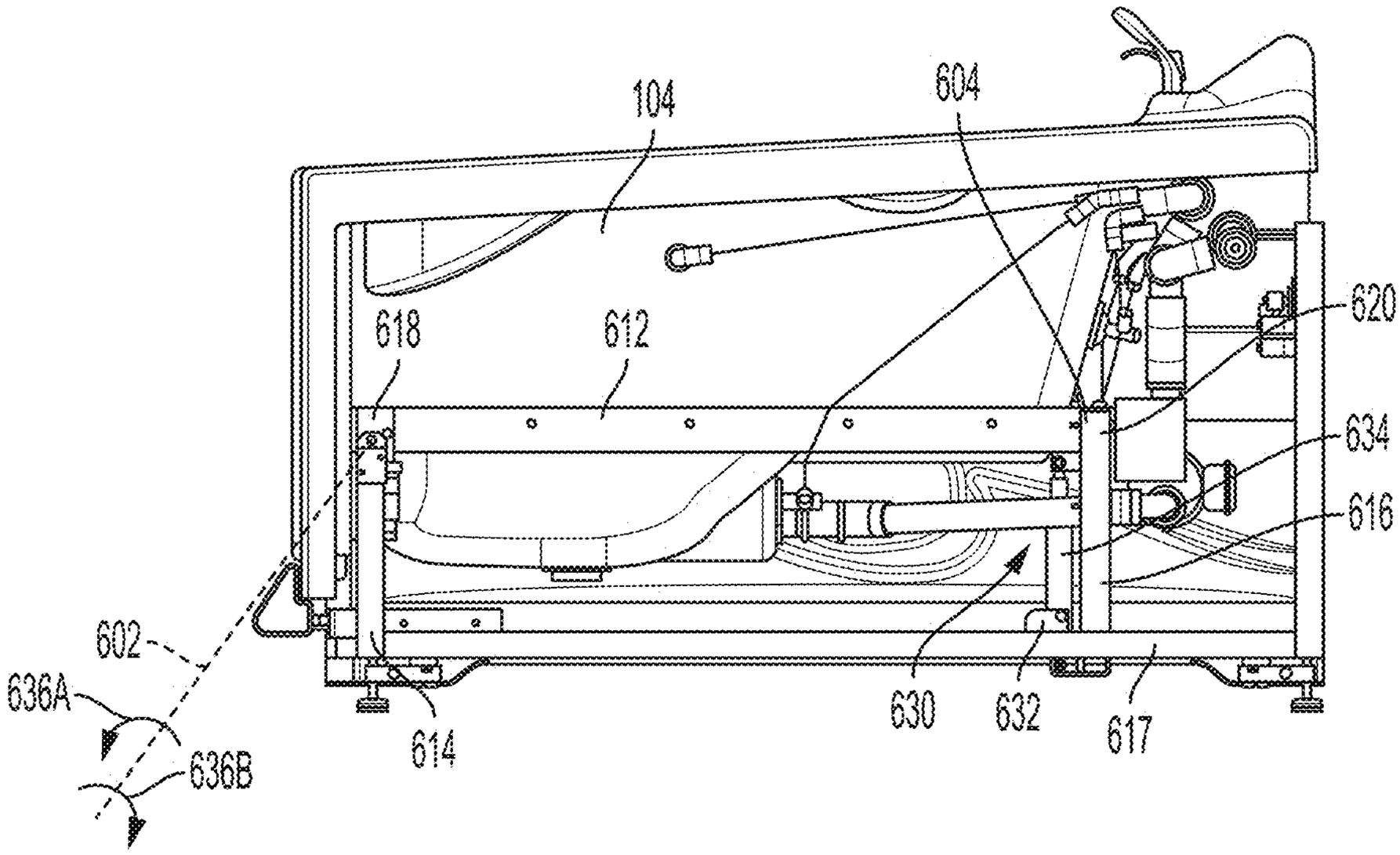
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FIG. 18

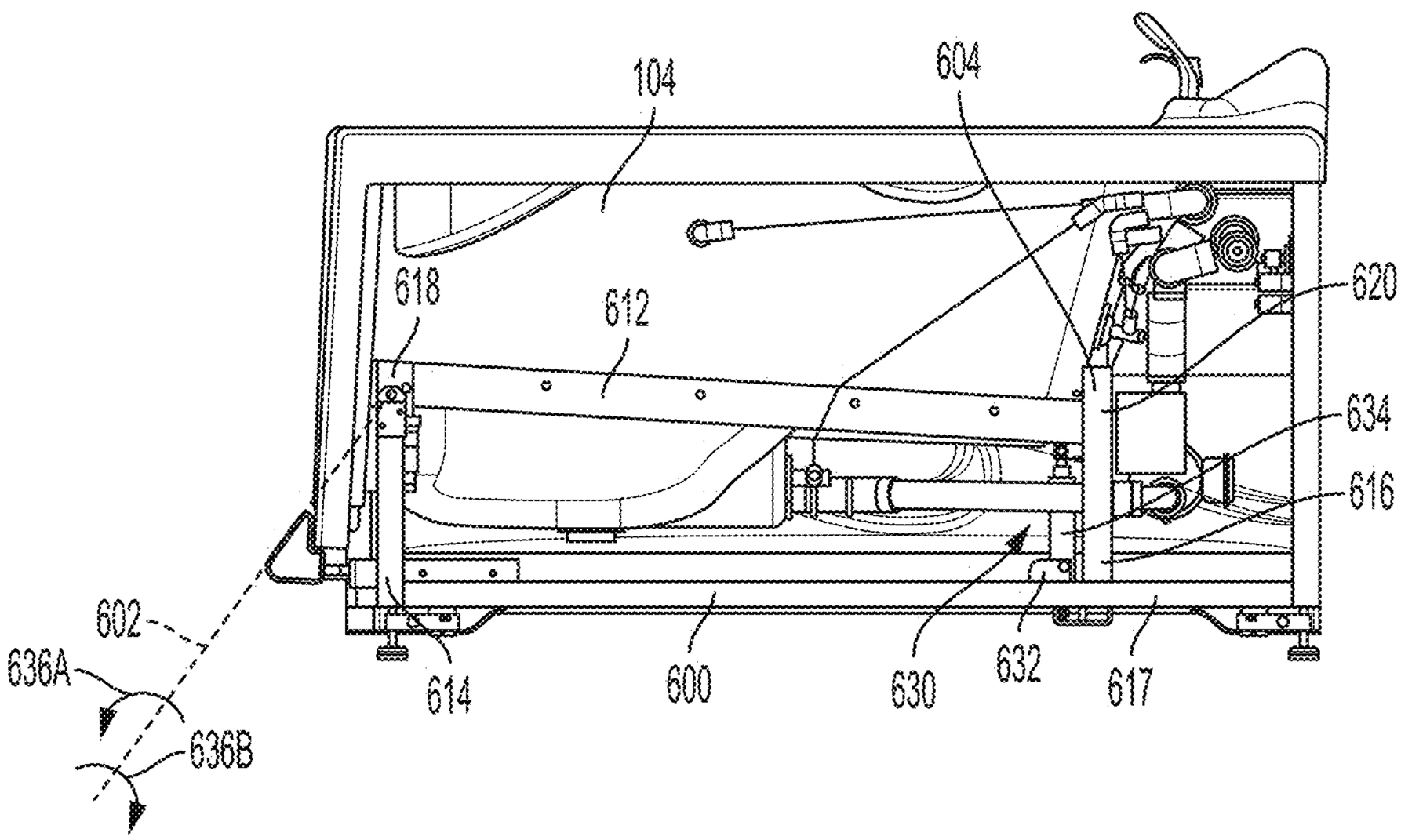
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FIG. 19

SYSTEMS AND METHODS FOR A BATHING SYSTEM

BACKGROUND

Immersion bathing and/or hydrotherapy for assisted and/or self-bathing in various medical care and long-term care institutions typically involves transporting a patient using a transfer system into a bathing tub. Many existing transfer methods do not adequately provide for patient dignity and safety and may be a source of embarrassment and/or anxiety for the bather. The safety shortcomings of such systems may sometimes result in fall, injury or even death of the patient due to user error, and/or lack of monitoring the transfer process.

SUMMARY

According to an embodiment, a bathing system, comprises a tub, comprising a tub chamber having a first support surface adjacent to a first lateral surface, and a second support surface being adjacent to the second lateral surface. The bathing system includes a transfer system, comprising: a carrier base comprising a first arm and a second arm opposite to the first arm, and a transfer seat operatively coupled to the carrier base, the transfer seat being lockable with respect to the carrier base to limit a first relative motion between the transfer seat and the carrier base, and the transfer seat being slidable with respect to the carrier base to facilitate relative motion between the transfer seat and the carrier base in a condition when the transfer system is engaged with the tub, the sliding of the transfer seat relative to the carrier base facilitating transfer of the transfer seat toward or away from the tub, wherein, when the transfer system is engaged to the tub, each of the first arm and the second arm of the carrier base extends into the tub such that the first arm overlaps with the first support surface over a first overlap distance, and the second arm of the carrier base overlaps with the second support surface of the tub over a second overlap distance.

In certain embodiments, the first overlap distance generally equals the second overlap distance. For instance, the first overlap distance equals between about 10% and about 50% of a depth of the first arm, and/or the second overlap distance equals between about 10% and about 50% of a depth of the second arm.

In optional embodiments, the transfer system may include a plurality of wheels operatively coupled to the transfer seat that may facilitate relative slidable movement between the transfer seat and the carrier base of the transfer system in the condition when the transfer system is engaged with the tub. Optionally, a first wheel may have a first surface and a second surface spaced apart from the first surface. The first surface may contact the first arm and the second surface may contact the first support surface. A second wheel may have a third surface and a fourth surface spaced apart from the third surface. The third surface may contact the second arm and the fourth surface may contact the second support surface. In certain embodiments, the first wheel may include a first spacer positioned between the first surface and the second surface for aligning the carrier base with respect to the first support surface. Further, optionally, the second wheel comprises a second spacer positioned between the third surface and the fourth surface, the second spacer aligning the carrier base with respect to the second support surface.

According to one embodiment, the first support surface comprises a first tapered leading surface, and the second support surface comprises a second tapered leading surface. The first tapered leading surface may facilitate engagement of the second surface to the first support surface, and the second tapered leading surface facilitating engagement of the fourth surface to the second support surface.

In an embodiment, the transfer system may include a first lock configured to lock the transfer seat to the carrier base and thereby limit the relative motion between the transfer seat and the carrier base.

Optionally, the transfer system may include a second lock comprising a second locking pin configured to lock the transfer seat to the carrier base and thereby limit the relative motion between the transfer seat and the carrier base. In certain embodiments, for instance, a first indent may be configured to capture the second locking pin to lock the transfer seat to the carrier base. The first support surface may include a second indent configured to capture the second locking pin after the transfer seat is received in the tub, to lock the transfer seat relative to the tub so as to limit a second relative motion between the transfer seat and the tub.

According to advantageous embodiments, the first support surface comprises a contoured portion, and the second locking pin comprises a transverse pin, the contoured portion engaging the transverse pin to unlock the second locking pin and thereby unlock the second lock after the transfer system engages with the tub. The transfer seat may include a handle configured to actuate the second lock and thereby lock or unlock the second locking pin with respect to portions of the carrier base and/or the tub.

In some embodiments, the tub and the carrier base may be locked with respect to each other by a tub lock. The tub lock may include a latch and the carrier base may include a carrier pin. In further optional embodiments, the carrier base may include a plurality of alignment wheels to abut a corresponding alignment surface of the tub and thereby align the transfer system with the tub. In such cases, the tub lock may be locked to the carrier base after alignment. For instance, the carrier pin is captured within the tub lock when each wheel of the plurality of alignment wheels abuts the corresponding alignment surface of the tub. Advantageously, the transfer seat is slidable with respect to the carrier base and slid into and/or out of the tub after the carrier pin is captured in the tub lock to improve safety of transfers.

In certain embodiments, the transfer seat and the carrier base may be in either a locked position or an unlocked position with respect to each other (e.g., via a first lock). The locked position may limit a first relative motion, for instance, relative sliding between the transfer seat and the carrier base. The unlocked position may facilitate relative motion, for instance, sliding between the transfer seat and the carrier base. The sliding of the transfer seat relative to the carrier base may facilitate transfer of the transfer seat toward or away from the tub.

The bathing system may include a plurality of sensors. At least a first sensor of the plurality of sensors may sense a position of a first component of the tub or a second component of the transfer system and to generate one or more signals representative thereof. The first sensor may sense the position of the first component of the tub or the second component of the transfer system during or after movement of the transfer system relative to the tub. A controller may be in operative communication with each sensor of the plurality of sensors. The controller may be configured to receive the one or more signals generated by the first sensor, and may

be configured to: determine, from the one or more signals, whether the position of at least the first component of the tub or the second component of the transfer system corresponds to a state where it is permissible to transfer the transfer seat toward or away from the tub; if the controller determines that the one or more signals corresponds to a first state where it is permissible to transfer the transfer seat toward or away from the tub, generate a first output, wherein, the first output includes a first signal for moving the transfer seat and/or the carrier base from the locked position to the unlocked position; and if the controller determines that the one or more signals corresponds to a second state where it is not permissible to transfer the transfer seat toward or away from the tub, generate a second output, wherein, the second output includes a second signal for maintaining the transfer seat and/or the carrier base in the locked position.

In optional embodiments, the first sensor may include a proximity sensor configured to sense whether the transfer system is engaged to the tub. The tub may include a tub lock and the carrier base may include a carrier pin. For instance, the tub lock may be a latch with a slot. The slot may capture the carrier pin, and thereby lock the carrier base relative to the tub. In such cases, the proximity sensor may be configured to sense a distance between the carrier pin and the tub lock is less than a threshold distance. If the distance between the carrier pin and the tub lock is less than the threshold distance, the controller may generate a first signal. Further, optionally, upon receipt of the first signal, the controller determines that the first signal corresponds to the first state where it is permissible to transfer the transfer seat toward or away from the tub. The controller determines that it is not permissible to transfer the transfer seat toward or away from the tub in the absence of the first signal.

In certain embodiments, a display may be in operative communication with the controller. The controller may be configured to communicate with the display to display the first output and/or the second output.

According to advantageous embodiments, the transfer seat may be lockable with respect to the carrier base by at least one lock. The plurality of sensors may include a second sensor to sense whether the at least one lock is in a locked state and generate a second signal. The controller may be in operative communication with the second sensor. Upon receipt of the second signal, the controller may be configured to generate a third output.

In one embodiment, the tub may include a tub door to move between an open position and a closed position, wherein, the tub door is in the open position during transfer of the transfer seat into the tub. In some such cases, a third sensor may sense whether the tub door is in the open position, and generate a third signal. Upon receipt of the third signal, the controller is configured to generate a fourth output. The third sensor may generate a fourth signal when the tub door is in the closed position. The controller may determine, based on the fourth signal whether the tub is in a state so as to be filled with liquids, and if the controller determines that the tub is in a state so as to be filled with liquids, initiate a tub fill operation, or if the controller determines that the tub is in a state not to be filled with liquids, prevent liquids from filling the tub to a level greater than a predetermined level.

Optionally, the bathing system may include one or more nozzles to generate one or more whirlpool jets. A fourth sensor may sense a level of liquid in the tub and generate a fifth signal. The controller may determine, based on the fifth signal, whether the tub is in a state so as to actuate the one or more nozzles. If the controller determines that the tub is in a state so as to actuate the one or more nozzles, actuate the one or more nozzles. The controller may determine, based on the fifth signal, whether the tub is in a state so as to not actuate the one or more nozzles, and if the controller determines that the tub is in a state so as to not actuate the one or more nozzles, does not actuate the one or more nozzles.

In further advantageous embodiments, a fifth sensor may sense a level of a cleaning solution in the tub during a cleaning operation. A sixth sensor configured to sense a temperature of a liquid in the tub.

Embodiments also include the following numbered embodiments:

1. A bathing system, comprising:

a tub, comprising:

a tub chamber defined by a bottom surface, a front surface, a back surface, a first lateral surface and a second lateral surface, the first lateral surface being opposite to the second lateral surface, the tub chamber configured to hold a liquid received from a liquid source, a first support surface the first support surface being adjacent to the first lateral surface, and a second support surface, the second support surface being adjacent to the second lateral surface; and

a transfer system, engageable with the tub, the transfer system comprising:

a carrier base comprising a first arm and a second arm opposite to the first arm, and a transfer seat operatively coupled to the carrier base, the transfer seat being lockable with respect to the carrier base to limit a first relative motion between the transfer seat and the carrier base, and

the transfer seat being slidable with respect to the carrier base to facilitate relative motion between the transfer seat and the carrier base in a condition when the transfer system is engaged with the tub, the sliding of the transfer seat relative to the carrier base facilitating transfer of the transfer seat toward or away from the tub,

wherein, when the transfer system is engaged to the tub, each of the first arm and the second arm of the carrier base extends into the tub such that the first arm overlaps with the first support surface over a first overlap distance, and the second arm of the carrier base overlaps with the second support surface of the tub over a second overlap distance.

2. The bathing system of embodiment 1, wherein the first overlap distance generally equals the second overlap distance.

3. The bathing system of embodiment 1 or 2, wherein the first overlap distance equals between about 10% and about 50% of a depth of the first arm, and/or the second overlap distance equals between about 10% and about 50% of a depth of the second arm.

4. The bathing system of embodiment 1 or any previous embodiment, wherein the transfer system comprises a plurality of wheels operatively coupled to the transfer seat, the plurality of wheels facilitating relative slidable movement between the transfer seat and the carrier base of the transfer system in the condition when the transfer system is engaged with the tub.

5. The bathing system of embodiment 4 or any previous embodiment, wherein, the plurality of wheels includes:

a first wheel having a first surface and a second surface spaced apart from the first surface, the first surface

being configured to contact the first arm and the second surface being configured to contact the first support surface; and

a second wheel having a third surface and a fourth surface spaced apart from the third surface, the third surface being configured to contact the second arm and the fourth surface being configured to contact the second support surface.

6. The bathing system of embodiment 5 or any previous embodiment, wherein the first support surface comprises a first tapered leading surface, and the second support surface comprises a second tapered leading surface.

7. The bathing system of embodiment 6 or any previous embodiment, wherein the first tapered leading surface facilitating engagement of the second surface to the first support surface, and the second tapered leading surface facilitating engagement of the fourth surface to the second support surface.

8. The bathing system of embodiment 1 or any previous embodiment, wherein the transfer system comprises a first lock configured to lock the transfer seat to the carrier base and thereby limit the relative motion between the transfer seat and the carrier base.

9. The bathing system of embodiment 8 or any previous embodiment, wherein the transfer system comprises a second lock comprising a second locking pin configured to lock the transfer seat to the carrier base and thereby limit the relative motion between the transfer seat and the carrier base.

10. The bathing system of embodiment 9 or any previous embodiment, wherein carrier base comprises a first indent configured to capture the second locking pin to lock the transfer seat to the carrier base.

11. The bathing system of embodiment 10 or any previous embodiment, wherein the first support surface comprises a second indent configured to capture the second locking pin after the transfer seat is received in the tub, to lock the transfer seat relative to the tub so as to limit a second relative motion between the transfer seat and the tub.

12. The bathing system of embodiment 10 or any previous embodiment, wherein the first support surface comprises a contoured portion, and the second locking pin comprises a transverse pin, the contoured portion engaging the transverse pin to unlock the second locking pin and thereby unlock the second lock after the transfer system engages with the tub.

13. The bathing system of embodiment 9 or any previous embodiment, wherein the transfer seat comprises a handle configured to actuate the second lock and thereby lock or unlock the second locking pin with respect to portions of the carrier base and/or the tub.

14. The bathing system of embodiment 1 or any previous embodiment, wherein the carrier base comprises a plurality of alignment wheels, each alignment wheel of the plurality of alignment wheels being configured to abut a corresponding alignment surface of the tub and thereby align the transfer system with the tub.

15. The bathing system of embodiment 14 or any previous embodiment, wherein the carrier base comprises a carrier pin and the tub comprises a latch, the latch having a slot configured to capture the carrier pin, and thereby lock the carrier base relative to the tub.

16. The bathing system of embodiment 15 or any previous embodiment, wherein the carrier pin is captured within the latch when each wheel of the plurality of alignment wheels abuts the corresponding alignment surface of the tub.

17. The bathing system of embodiment 14 or any previous embodiment, wherein the transfer seat is slidable with respect to the carrier base and slid into and/or out of the tub after the carrier pin is captured in the latch.

18. The bathing system of embodiment 5 or any previous embodiment, wherein the first wheel comprises a first spacer positioned between the first surface and the second surface, the first spacer vertically aligning the carrier base with respect to the first support surface.

19. The bathing system of embodiment 5 or any previous embodiment, wherein the second wheel comprises a second spacer positioned between the third surface and the fourth surface, the second spacer vertically aligning the carrier base with respect to the second support surface.

20. The bathing system of embodiment 19 or any previous embodiment, wherein the first spacer vertically aligning the transfer seat to the first arm of the carrier base, and the second spacer vertically aligning the transfer seat to the second arm when transferring the transfer seat out of the tub.

The details of one or more examples are set forth in the accompanying drawings and the description below. Other features, objects, and advantages will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1**A illustrates a perspective view of an exemplary bathing system according to a non-limiting embodiment;

FIG. **1**B illustrates a perspective view of an exemplary transfer system according to a non-limiting embodiment;

FIG. **1**C illustrates a schematic view of various components of the bathing system of FIGS. **1**A and **1**B;

FIG. **2** illustrates a perspective view of the bathing system of FIG. **1**A, prior to transfer of the transfer seat into the tub;

FIG. **3** illustrates a perspective view of the bathing system of FIG. **1**A, after transfer of the transfer seat into the tub;

FIG. **4**A illustrates a lower front view of the tub of FIG. **1**A with the carrier base of FIG. **1**B docked to the tub;

FIG. **4**B illustrates an enlarged lower front view of the tub of FIG. **1**A to illustrate portions of the tub lock;

FIG. **5** illustrates a lower front view of the tub of FIG. **1**A with the carrier base of FIG. **1**B unlocked to the tub;

FIG. **6** illustrates a lower front view of the tub of FIG. **1**A with the carrier base of FIG. **1**B locked to the tub;

FIG. **7** illustrates a top view of the tub of FIG. **1**A with the carrier base of FIG. **1**B docked to the tub;

FIG. **8** illustrates a side view of the tub of FIG. **1**A with the carrier base of FIG. **1**B docked to the tub;

FIG. **9** illustrates a front view of the tub of FIG. **1**A with the carrier base of FIG. **1**B docked to the tub;

FIG. **10** illustrates an enlarged perspective view of a first lock of the transfer system according to an embodiment shown in a locked state;

FIG. **11** illustrates a side view of the first lock of FIG. **10** shown in a locked state;

FIG. **12** illustrates a side view of the first lock of FIG. **10** shown in an unlocked state;

FIG. **13** illustrates a bottom perspective view of a second lock according to an embodiment shown in a locked state;

FIG. **14** illustrates a front view of the second lock of FIG. **13** during transfer of the transfer seat into the tub;

FIG. **15** illustrates a bottom perspective view of the second lock of FIG. **13** locked into an indent of the first support surface;

FIG. **16** illustrates a bottom perspective view of the second lock of FIG. **13** locked into an indent of the first support surface;

FIGS. **17**A, **17**B, **17**C and **17**D illustrates exemplary control algorithms;

FIG. **18** illustrates a side view of the bathing system of FIG. **1**A with the tub chamber in a transfer position according to an embodiment; and

FIG. **19** illustrates a side view of the bathing system of FIG. **18** with the tub chamber in an immersed position according to an embodiment.

DETAILED DESCRIPTION

Illustrative embodiments disclosed herein relate to a bathing system **100** for use in immersion bathing and/or hydrotherapy sessions for patients in medical care and long-term care institutions.

Tub Architecture

FIGS. **1**A and **1**B illustrate perspective views of exemplary embodiments of a bathing system **100** and portions of a transfer system **200** while FIG. **1**C illustrates a schematic of the bathing system **100** and transfer system **200** according to several disclosed embodiments. The bathing system **100** may include a tub **102**. The tub **102** may include a tub chamber **104**. The tub chamber **104** can be defined by a bottom surface **108**, a front surface **110**, a back surface **112**, a first lateral surface **114** and a second, opposite, lateral surface **116**.

The tub chamber **104** may hold a liquid received from a liquid source **118** (e.g., liquid tank, a water supply conduit, etc.). In certain aspects, the tub **102** may include one or more inlet ports **120** in operative communication with the liquid source **118** to receive, and thereby fill the tub chamber **104**. In one embodiment, the liquid may include water. In such cases, the tub may be receive water at desired temperature. In optional embodiments, the tub may be in fluid communication with a hot water port and a cold water port to receive hot and cold water, respectively. In another embodiment, the liquid may include a bathing, skin care, and/or hydrotherapy product in combination with water. In yet another embodiment, the liquid may include a cleaning solution for cleaning the tub chamber **104** when not in use. Additionally, the liquid may include a disinfecting liquid dispensed into the tub to reduce or eliminate any pathogens present on the tub surfaces. Periodic cleaning and disinfecting may lead to improved sanitary conditions, and may be performed in conjunction with a controller. In such cases, instructions for cleaning and/or disinfecting. Additionally, the controller may automatically dispense and/or dilute the liquids to suitable concentrations during cleaning and/or dispensing cycles, to ensure that cleaning and dispensing operations are performed consistently and correctly to comply with regulatory standards.

The inlet port **120** may be situated anywhere on the tub chamber **104**. In advantageous aspects, the inlet port **120** may be positioned below a center-plane of the tub chamber **104** (e.g., at or near the bottom surface **108** as seen in FIG. **1**A). Such embodiments may allow for reduced noise during filling of the tub **102** and/or less turbulent filling of the tub **102**, in turn ensuring comfort for persons suffering cognitive impairments such as anxiety, dementia, Alzheimer's disease, or others.

In certain optional embodiments, and with continued reference to FIGS. **1**A and **1**C, the tub chamber **104** may include a fluid agitation system **122**. The fluid agitation system **122** may be a whirlpool system in some embodiments. Alternatively or in addition, the fluid agitation system **122** may be an air spa system. In each case, the fluid agitation system **122** can include one or more nozzles **130** that can generate a jet of fluid (liquid, in the case of whirlpool system, or air in the case of air spa system). In embodiments where the fluid agitation system **122** is a whirlpool system, a whirlpool pump **132** may be provided and may be in fluid communication (e.g., directly, or indirectly via the inlet port **120**) with the liquid source **118** and/or the one or more nozzles **130**. In some such embodiments, the fluid agitation system **122** can also include one or more liquid circulation outlets **134**. The nozzles **130** and/or outlets can be shaped, oriented and/or positioned to provide desirable liquid circulation properties. For instance, in an embodiment, the liquid circulation outlets **134** can be shaped and oriented to increase aeration at certain flow rates, while reducing backpressure within the whirlpool system. Advantageously, such embodiments may facilitate the use of a smaller whirlpool pump **132**, a lower overall power consumption or reduced noise during operation of the bathing system **100**.

In optional embodiments, the bathing system **100** may include a pre-fill tank **136** in fluid communication with the liquid source **118**. The pre-fill tank **136** may advantageously provide a faster filling of the tub chamber **104**. In some embodiments, the pre-fill tank **136** may communicate with the liquid source **118** prior to the use of the tank, and may store a desired quantity of liquid, which may correspond to a sufficient volume of liquid (e.g., water) to fill the tub. (e.g., several gallons of water). The pre-fill tank **136** may include a pre-fill level sensor (e.g., a float valve) to monitor the level of liquid in the pre-fill tank **136**, and fluidly decouple the pre-fill tank **136** from the liquid source **118**. In certain aspects, the pre-fill tank **136** may fluidly communicate with the tub chamber **104** via gravity to fill the tub chamber **104**. In additional or alternative embodiments, the pre-fill tank **136** may be in operative communication with a whirlpool pump **132** of the whirlpool system to facilitate accelerated filling of the tub chamber **104**. Such embodiments may reduce the wait time for filling the tub chamber **104**, and may advantageously be automated, as will be described further herein.

According to certain exemplary embodiments, several components of the tub **102** may include electronic components and may be controlled by a controller **400** according to one or more control algorithms. In one example, the tub **102** may include fill valves **140** that may include electronic components (e.g., valves) that may be actuated electronically (e.g., via a signal) to open or close. The fill valves **140** may be in fluid communication with the liquid source **118** to permit filling of the tub **102** with liquid from the liquid source **118**. Optionally, the tub **102** may include a shower wand **142** as shown in FIG. **1**A. The shower wand **142** may include another electronic valve in fluid communication with the liquid source **118** to permit flow of liquid from the liquid source **118** to the shower wand **142**. One or more temperature sensors may monitor temperature of liquid entering the fill valve and/or the shower wand **142**. The temperature of incoming liquid may also be controlled using an auxiliary control system (e.g., a thermostatic mixing valve). In embodiments where a thermostatic mixing valve is provided, the thermostatic mixing valve may adjust flow rates of hot and cold liquid (e.g., water) to reach a desired

water temperature. Advantageously, the thermostatic mixing valve may facilitate maintaining the liquid at a constant temperature despite pressure or temperature variations that may occur in the liquid supply, for instance, in hot and cold water sources. Additionally, the thermostatic mixing valve may be in operative communication with a temperature sensor and a controller (to be described further), and may monitor the temperature of the liquid to ensure that the liquid temperature is less than a maximum temperature (e.g., to reduce the chances of accidental scalding).

In further optional embodiments, the tub chamber **104** may include one or more drains **150** to permit drainage of liquids in the tub chamber **104**. The drains **150** may be electrically actuable. For example, each of the one or more drains **150** may include an electronic valve **152** which may be actuated (e.g., via an electric signal) to open or close to drain or stop drainage of the liquids from the tub **102**. In additional or alternative embodiments, drainage of liquids may be accelerated by engaging the whirlpool pump. In such cases, a plurality of valves may be provided and in fluid communication with the whirlpool nozzles, pump **132**, drains **150**. A valve of the plurality of valves may fluidly disconnect the whirlpool nozzles from the whirlpool pump **132**. Another valve may fluidly connect the whirlpool pump **132** to the drain. Actuation of the whirlpool pump **132** in this state may, instead of actuating the nozzles, facilitate drainage of the tub.

In certain aspects, with continued reference to FIG. **1**A, the tub **102** may include several advantageous features, such as a plurality of removable side panels for ease of access for maintenance, integrated arm rests for the patient, and the like. Optional components may also include a weighing system comprising one or more distributed load cells, which may take a patient's weight while in the tub **102**.

With continued reference to FIG. **1**A, to the tub **102** includes a tub door **170**. The tub door **170** may be movable between a closed position as illustrated in FIG. **1**A and an open position as illustrated in FIGS. **2** and **3**. The tub door **170** may be locked into the closed position by a mechanical connection (e.g., pawls, fasteners, locks, and the like). The tub door **170** may be connected to the tub chamber **104** by a hinged connection. As best seen in FIGS. **2** and **3**, the tub door **170** may include one or more seals **172** that may provide a fluid-tight seal to reduce or eliminate fluid leaks when the tub door **170** is closed. As mentioned previously, the tub chamber **104** may be defined by one or more tub **102** surfaces, including a tub **102** front surface **110**. In the illustrated embodiments of FIGS. **1**A, **2** and **3**, the tub **102** front surface **110** is an interior surface of the tub door **170**.

Transfer System Overview

Referring to FIG. **1**B, the bathing system **100** includes a transfer system **200**. The transfer system may be useful for transferring a patient (e.g., a patient in a medical care facility or a resident in a long-term care facility) from a location (e.g., a room in a medical or long-term care facility) into the tub **102**. The transfer system may be engageable with respect to the tub **102** to facilitate transfer of a patient into or out of the tub **102**, as will be described further below. The transfer system, as seen in FIG. **1**B, may include a transfer seat **202** for receiving a patient in a seated position. The transfer seat **202** may be supported by a carrier base **204**.

With continued reference to FIG. **1**B, in optional embodiments, the transfer seat **202** may be contoured for resident comfort and support. In additional optional embodiments, the transfer seat **202** may include support surfaces that support the person seated in the transfer seat **202**. For instance, in one embodiment, the transfer seat surfaces **208** may cradle the torso of a person seated in the transfer seat **202**, so as to facilitate more upright seating. Such embodiments may be beneficial for persons with poor muscle control. In additional or alternative aspects, the transfer seat **202** may include a movable and repositionable lumbar support pad **210** that may be positioned and/or repositioned to best support the resident. The transfer seat **202** may also include one or more restraints or safety belts, such as belts, harnesses and the like to support and/or restrain a patient during transportation via the transfer system and/or during bathing to improve safety.

In further optional embodiments, the transfer seat **202** may include one or more openings **216**. During use, the openings **216** may facilitate drainage of liquids. Optionally, the openings **216** may be provided at locations that form lowermost portions of the transfer seat **202**. In certain embodiments, one or more openings **216** may also facilitate exposure of a patient's perineal region. Such embodiments may facilitate directing liquid from one or more nozzles **130** (e.g., of the whirlpool system) toward a patient's perineal region to augment caregiver's administration of perineal hygiene.

As seen in FIG. **1**B, in illustrative embodiments, the transfer seat **202** may include a handle **220**. The handle **220** may advantageously be positioned to the rear of a centerplane of the transfer seat **202**. During use, a caregiver may grasp the handle **220** for maneuvering the transfer system, and optionally, for positioning the transfer seat **202** within the tub **102** as will be described further below.

FIG. **2** illustrates the transfer seat **202** during the process of transfer, while FIG. **3** illustrates the transfer seat **202** when the transfer seat **202** has been transferred into the tub **102**. After transfer of the transfer seat **202**, the carrier base **204** may be undocked from the tub **102** and may be moved out of the way of the tub door **170**. The tub door **170** may then be closed and the tub **102** filled with water. The carrier base **204** may be re-docked to the tub **102** to facilitate the transfer of the transfer seat **202** from the tub **102** toward the carrier base **204**.

In certain optional embodiments, as seen in FIG. **1**B, the carrier base **204** may include removable and position-adjustable footrests **222** to support a patient's feet. The footrests may provide support to the patient's feet while the transfer seat **202** is exterior to the tub **102** (e.g., during transportation of the patient). The footrests may be adjusted to accommodate varying leg lengths. Optionally, the foot rests may be removed from the carrier base **204**.

With continued reference to FIG. **1**A, according to some embodiments, the carrier base **204** may include a pair of lateral handles **224**. The lateral handles **224** may be coupled to and extend from the carrier base **204**. The lateral handles **224** may facilitate moving the transfer system (e.g., by a caregiver), when a caregiver is standing in front of a patient. For instance, during use, the caregiver may grasp the lateral handles **224** and push or pull the transfer seat **202** in a guided fashion using the lateral handles **224** to move the transfer seat **202** relative to the tub **102**. In advantageous aspects, the lateral handles **224** may be pivotable relative to the carrier base **204**. For example, the lateral handles **224** may pivot upwards and outwards (e.g., as shown in FIG. **1**B) to move out of the way during seating of a patient into the transfer seat **202**, or during transfer of the patient from the transfer seat **202**, so as to not obstruct access to the patient.

According to illustrative embodiments, components of the transfer system may be made of waterproof materials. In certain advantageous aspects, the transfer seat **202** may include an antimicrobial material. Further, in optional

embodiments, the transfer seat **202** may include a removable commode pan for patient incontinence prior to bathing and/or hydrotherapy.

As mentioned previously, the transfer seat **202** may be supported by a carrier base **204**. The transfer seat **202** may be operatively (e.g., slidably) coupled to the carrier base **204**. For instance, in certain instances, the transfer seat **202** may be slidable with respect to the carrier base **204** to facilitate relative motion between the transfer seat **202** and the carrier base **204**, thereby facilitating transfer of the transfer seat **202** toward or away from the tub **102** (e.g., as illustrated in FIGS. **2** and **3**). In other instances, the transfer seat **202** may be lockable with respect to the carrier base **204** to limit a first relative motion between the transfer seat **202** and the carrier base **204** prior to engagement of the transfer system and the tub **102**.

Referring again to FIG. **1**B, the carrier base **204** may be supported by a plurality of wheels **230**. The wheels may, in some embodiments, be casters. One or more casters may optionally swivel for controlled movement of the transfer seat when used with high weight loads. In such embodiments, the caster(s) that swivel may include a mechanical lock to lock the caster(s) from moving while patients move into or out of the transfer seat. The mechanical lock may also offer additional safety when the carrier base is docked to the tub. While the illustrated embodiment shows four wheels, additional or fewer wheels are contemplated within the scope of the present disclosure. The plurality of wheels may permit transportation of a patient seated in the transfer seat **202**.

Tub Carrier Base Docking System

Referring now to FIGS. **4**A-**4**B, the carrier base **204** and the tub **102** may each include cooperative elements that may cooperate to dock the carrier base **204** relative to the tub **102**. The docking may restrict relative motion between the carrier base **204** and the tub **102** to facilitate transfer of the patient. In some embodiments, the carrier base **204** may be aligned with respect to the tub **102**. In such embodiments, the carrier base **204** may include a plurality of alignment wheels **240**. Each alignment wheel may abut a corresponding alignment surface **242** of the tub **102** to align the transfer system with the tub **102** prior to engaging therewith. In alternative or additional embodiments, the transfer system may include corresponding structures on the tub and the carrier base to provide alignment. Such corresponding structures may include complementary surfaces, tapered pins and/or holes, and the like that may engage with each other to provide alignment between the transfer system and the tub.

Referring back to FIG. **1**B, in certain optional embodiments, the alignment wheels **240** may have a rotational axis **244** generally perpendicular to the axis of rotation **246** of the wheels of the carrier base **204**. For instance, in the illustrated embodiment, the alignment wheels **240** may be disposed on a generally horizontal plane, with a rotational axis disposed generally vertically. However, in alternative embodiments, the alignment wheels **240** may be at other orientations.

As seen in FIGS. **1**B and **4**A, the alignment wheels **240** may abut a corresponding alignment surface **242**. In the illustrated embodiment, the alignment wheels **240** may be provided on the bottom portion of the carrier base **204**. Similarly, the corresponding alignment surfaces **242** may be provided on a bottom portion of the tub **102**. Alternatively, alignment wheels **240** and the aligning surfaces may be provided on other surfaces. While alignment wheels **240** and aligning surfaces are illustrated, other types of structures (e.g., frictional engagement of cooperative mechanical structures, electronic systems, etc.) that may provide alignment (or an indication of offset) between the transfer system and the tub **102** are contemplated within the scope of the present disclosure.

Referencing FIGS. **4**A, **4**B, **5** and **6**, the carrier base **204** and the tub **102** may include cooperative structures to lock the carrier base **204** with respect to the tub **102** to restrict relative motion therebetween. For instance, in the illustrated embodiment, the carrier base **204** may have a carrier pin **250**. The tub **102** may include a tub lock **252**. Any type of lock can be used. In the illustrated exemplary embodiment, the tub lock **252** may include a latch with a pair of spring-biased jaws **254**. The spring-biased jaws may be actuated (e.g., mechanically by a caregiver, automatically upon detection of the carrier base **204**, etc.) to capture the carrier pin **250**, and thereby lock the carrier base **204** with respect to the tub **102**. In one example, actuation of the spring-biased jaws to capture the carrier pin **250** may be accomplished by the carrier pin **250** bearing against the surface of the jaws **254** (e.g., in a manner similar to actuation of a car door latch). Alternatively, the actuation of the spring-biased jaws may be accomplished by other mechanical or electronic systems, or a combination thereof. As will be further described below with reference to FIGS. **17**A-D, the tub lock **252** may be monitored by a controller to ensure that the tub lock **252** is in a closed position and/or not mechanically releasable during transfer. Additional sensors (e.g., proximity sensors) may monitor and ensure that the carrier pin **250** is captured within the tub lock **252** prior to, or during transfer. Once locked, the transfer system has been engaged with the tub **102**, and the bathing system **100** may be ready for transfer of a patient into or out of the tub **102**.

Resident Transfer Mechanism

With reference to FIGS. **1**A and **7**, the tub **102** may include a first support surface **256** and a second support surface **258**. The first support surface **256** may be adjacent to the first lateral surface **114**. The second support surface **258** may be adjacent to the second lateral surface **116**. The first support surface **256** and the second support surface **258** may therefore be opposite to each other. Each of the first support surface **256** and the second support surface **258** may support the transfer seat **202** during transfer and/or during use of the tub **102**, as will be described further below.

Referring to FIGS. **7-9**, the carrier base **204** may include a first arm **260** and a second arm **262**. The first arm **260** may be opposite to the first arm **260**. When the transfer system is engaged to the tub **102**, the first arm **260** may extend into the tub **102** and may be adjacent to the first support surface **256**. The second arm **262** may also extend into the tub **102** and may be adjacent to the second support surface **258**. The first arm **260** may be closest to the first support surface **256** than to the second support surface **258**, whereas the second arm **262** may be closest to the second support surface **258** than to the first support surface **256**.

As seen in FIG. **7**, the first arm **260** extends adjacent to (e.g., overlaps with) the first support surface **256** over a first overlap distance **264**. The second arm **262** extends adjacent to (e.g., overlaps with) the second support surface **258** over a second overlap distance **266**. The overlap between the first support surface **256** and the first arm **260** and the second support surface **258** and the second arm **262** may provide a transfer experience that may be more secure, safe and comfortable for the patient.

In advantageous embodiments, the first arm **260** may be generally at the same vertical level as the first support surface **256**. The second arm **262** may be generally at the same vertical level as the second support surface **258**. Alternatively, the first arm **260** may be at a different vertical

level from the first support surface **256**. The second arm **262** may be at a different vertical level from the second support surface **258**. In certain aspects, the first arm **260** and the second arm **262** may generally be at the same vertical level as each other. Alternatively, the first arm **260** and the second arm **262** may be at different vertical levels. An embodiment in which the first arm **260** and the second arm **262** are each generally at the same vertical level as each other, and at the same vertical level as the first support surface **256** and/or the second support surface **258** may improve the transfer experience for the patient by providing a smooth transfer.

In some illustrative embodiments, the first overlap distance **264** may equal between about 10% and about 50% of a depth **268** of the first arm **260**. Further, the second overlap distance **266** may equal between about 10% and about 50% of a depth **270** of the second arm **262**. In certain optional embodiments, the first arm **260** and the second arm **262** may be of equal depths. Accordingly, the first overlap distance **264** and the second overlap distance **266** may be equal to each other in some such embodiments. By providing a substantial overlap distance, the transfer system may reduce the chances of poor engagement of transfer system components to the tub **102**, and may reduce the chances of inadvertently causing injury to the patient during transfer.

With continued reference to FIGS. **7** and **9**, the transfer system may include a plurality of wheels **280**A-D operatively coupled to the transfer seat **202**. The plurality of wheels **280**A-D may facilitate relative slidable movement between the transfer seat **202** and the carrier base **204** of the transfer system in the condition when the transfer system is engaged with the tub **102**, as will be described further below. As seen from FIGS. **7** and **9**, the plurality of wheels **280**A-D includes a first wheel **280**A, a second wheel **280**B, a third wheel **280**C and a fourth wheel **280**D. While four wheels are illustrated, additional or fewer wheels are contemplated within the scope of the present disclosure.

As may be appreciated from FIGS. **7** and **9**, the wheels **280**A-D of the transfer seat **202** may roll relative to the first support surface **256** and the second support surface **258** of the tub **102**, as will be described further below. In certain advantageous aspects, the wheels **280**A-D, the first support surface **256** and the second support surface **258** may each have significantly low coefficient of friction to facilitate ease of movement even when transferring bariatric residents. Materials that may be suitable include nylon (66), UHMW-PE, acetal (Delrin). In such cases, the transition from the transfer seat **202** to the tub **102** may be imperceptible by the resident.

The first wheel **280**A may have a first surface **282**. The first wheel **280**A may also have a second surface **284**. The first surface **282** and the second surface **284** may be exterior (e.g., cylindrical) surfaces of the first wheel **280**A. The first surface **282** and the second surface **284** may be spaced apart, for instance, by a first spacer **286**. The first spacer **286** may optionally align (horizontally and/or vertically) the carrier base and/or transfer seat with the first support surface. During transfer of the patient (e.g., from or to the tub **102** after the carrier base **204** has been docked to the tub **102**), the first surface **282** may contact the first arm **260** and the second surface **284** may contact the first support surface **256**. In some advantageous embodiments, as a result of the extension of the first arm **260** and the first support surface **256** over the first overlap distance **264**, the first surface **282** may contact the first arm **260** simultaneously when the second surface **284** may contact the first support surface **256**. The simultaneous contact between the first surface **282** and first arm **260**, and the second surface **284** and the second arm **262** may occur as the first wheel **280**A has rolled until a proximal end of the first arm **260**.

The second wheel **280**B may have a third surface **288**. The second wheel **280**B may also have a fourth surface **290**. The third surface **288** and the fourth surface **290** may be exterior (e.g., cylindrical) surfaces of the second wheel **280**B. The third surface **288** and the fourth surface **290** may be spaced apart, for instance, by a second spacer **292**. The second spacer may optionally align (horizontally and/or vertically) the carrier base and/or transfer seat with the second support surface. The first and the second spacers may each also align the transfer seat (horizontally and/or vertically) to the first arm and the second arm respectively of the carrier base, when transferring the transfer seat out of the tub. During transfer of the patient (e.g., from or to the tub **102**), the third surface **288** may contact the second arm **262** and the fourth surface **290** may contact the second support surface **258**. In some advantageous embodiments, as a result of the extension of the first arm **260** and the first support surface **256** over the first overlap distance **264**, the first surface **282** may contact the first arm **260** simultaneously when the second surface **284** may contact the first support surface **256**. The simultaneous contact between the third surface **288** and second arm **262**, and the fourth surface **290** and the third arm may occur as the second wheel **280**B has rolled until a proximal end of the second arm **262**.

In various optional aspects, the first support surface **256** and the second support surface **258** may be contoured such that small misalignment between the carrier base **204** and the tub **102** may not lead to reduced safety or discomfort during transfer. For example, as illustrated in FIGS. **7** and **9**, the first support surface **256** may include a first tapered leading surface **294** that may taper generally in a vertical direction. Further, in additional optional embodiments, the second support surface **258** may also include a second tapered leading surface **296** that may taper generally in a vertical direction. If, for instance, the carrier base **204** is docked such that the first arm **260** is not at the same vertical level as the first support surface **256**, the generally vertical tapering of the first tapered leading surface **294** may facilitate engagement of the second surface **284** of the first wheel **280**A to the first support surface **256**. Similarly, if, for instance, the carrier base **204** is docked such that the second arm **262** is not at the same vertical level as the second support surface **258**, the tapering of the second tapered leading surface **296** may facilitate engagement of the fourth surface **290** of the second wheel **280**B to the second support surface **258**.

In some optional embodiments, the first tapered leading surface **294** may form an angle **298** between about 120 degrees and about 180 degrees with respect to the first support surface **256**, for instance, about 150 degrees. In further optional embodiments, the second tapered leading surface **296** may form an angle between about 120 degrees and about 180 degrees, for instance, about 150 degrees. Such advantageous positioning and orientation of the first tapered leading surface **294** and the second tapered leading surface **296** may accommodate mismatched heights of the tub **102** and the carrier base **204** and under practical circumstances, reduce the chances of needing mechanical adjustments to assure adequate vertical alignment of the carrier base **204** and tub **102**.

Position Locking

As mentioned previously, the transfer seat **202** may be lockable with respect to the carrier base **204** to limit relative motion between the transfer seat **202** and the carrier base **204** prior to engagement of the transfer system and the tub

102. According to certain embodiments, the transfer system may include one or more locks as will be described further with reference to FIGS. **10-16**.

As shown in FIGS. **10-12**, the transfer system may include a first lock **300**. The first lock **300** may lock the transfer seat **202** to the carrier base **204** and thereby limit the relative motion between the transfer seat **202** and the carrier base **204** prior to engagement of the transfer system and the tub **102**. The first lock **300** may be any type of commonly known mechanical or electronic (or a combination thereof) locks. For instance, in one embodiment (as illustrated), the first lock **300** may be similar to the tub lock **252**. As shown in FIGS. **11** and **12** the first lock **300** may include a pair of spring-biased jaws **302**. The spring-biased jaws may be provided on the carrier base **204** in some embodiments. In such embodiments, a first locking pin **304** may be provided on the transfer seat **202**. Alternatively, the spring-biased jaws **302** may be provided on the transfer seat **202**, and the first locking pin **304** may be provided on the carrier base **204**. The spring-biased jaws **302** may be actuated (e.g., mechanically by a caregiver, automatically, etc.) to capture the first locking pin **304**, and thereby lock the carrier base **204** with respect to the transfer seat **202**. In one example, actuation of the spring-biased jaws **302** to capture the first locking pin **304** may be accomplished by the first locking pin **304** bearing against the surface of the jaws **302** (e.g., in a manner similar to actuation of a car door latch). Alternatively, the actuation of the spring-biased jaws **302** may be accomplished by other mechanical or electronic systems, or a combination thereof. Once locked, the transfer seat **202** may not have relative motion with respect to the carrier base **204**.

In certain aspects, the transfer system may include a second lock. The second lock may enhance safety during transportation of the patient. The second lock may be any type of mechanical or electronic (or a combination thereof) lock. For instance, as illustrated in FIGS. **13-16**, in one embodiment, the second lock may include a second locking pin **308**. The second locking pin **308** may be provided on the transfer seat **202** in some embodiments. In such embodiments, the carrier base **204** may include one or more indents **310** to capture the second locking pin **308**. Alternatively, the second locking pin **308** may be provided on the carrier base **204** and the transfer seat **202** may include one or more indents **310**. In the illustrated embodiment, as shown in FIG. **13**, the second locking pin **308** extends from a bottom portion of the transfer seat **202** toward the carrier base **204**. When the second locking pin **308** abuts the indent **310**, the second locking pin **308** may be captured within the indent **310** of the carrier base **204** to restrict relative motion between the carrier base **204** and the transfer seat **202**.

With continued reference to FIGS. **13** and **14**, the second locking pin **308** may include a transverse pin **312**. Certain surfaces of the transfer system and/or the tub **102** may bear on the transverse pin **312** to maintain the second locking pin **308** in an extended, unlocked stated during transfer of the patient, as will be described further below. As shown in FIG. **14**, the first support surface **256** of the tub **102** may include a contoured portion **314**. The contoured portion **314** may have a bottom surface **316** that may abut the transverse pin **312** during transfer. Further, bearing of the bottom surface **316** may lead to the second locking pin **308** to disengage the indent **310** to automatically unlock the transfer seat from the carrier base when the carrier is docked to the tub, thus enabling transfer. While not illustrated in FIG. **14**, the second support surface **258** of the tub **102** may also include a similar contoured portion.

Referring now to FIGS. **15** and **16**, the first support surface **256** may also include one or more indents **320** (e.g., opposite to the portion contacting the wheels **280**A, which may cooperate with the second locking pin **308** to lock the transfer seat **202** relative to the tub **102**, and thereby restrict relative motion between the transfer seat **202** and the tub **102**. For instance, the first support surface **256** may include one or more indent(s) **320**. The indent(s) **320** may capture the second locking pin **308** to lock the transfer seat **202** with relative to the tub **102**, and thereby restrict relative motion between the transfer seat **202** and the tub **102**. When the transverse pin **312** encounters at least one of the indents **320**, the second locking pin **308** may be actuated (e.g., manually or automatically) to retract into the indent **320**, and thereby by captured within the indent **320**. While not illustrated in FIGS. **15** and **16**, the second support surface **258** of the tub **102** may also include indent(s) similar to the indent(s) **320**. As will be described further below, the deactivation of the first locking pin **304** and/or the second locking pin **308** may be accomplished automatically via electrical controls by a control system upon determination that the system is in a state where it is permissible to transfer a patient.

Control System

According to certain advantageous aspects of the present disclosure, several of the mechanical components described herein may be electronically actuated and/or computer controlled. FIG. **1**C is a schematic that illustrates one such embodiment. In such cases, as shown in FIG. **1**C, aspects of the disclosure may include a controller **400** to control the operation of various components of the bathing system **100**. The controller **400** can be a programmable motor controller **400**, a programmable computer such as a microprocessor, a programmable logic controller **400**, and the like, and may include (and/or be in communication with) on-board or remote non-transitory storage media for storing instructions in the form of algorithms and/or data. The controller **400** may also be application specific integrated circuits (ASICs), microcontrollers, microprocessors, field-programmable gate arrays (FPGAs), or any other appropriate structure capable of receiving and processing data, as well as, circuitry distributed across a network to receive and process data and control system operation as described herein from a remote location. In aspects of the present disclosure, the controller **400** may receive electrical signals from one or more sensors described herein and can execute one or more control algorithms disclosed herein.

Sensors

In some illustrative examples, the bathing system **100** may include one or more sensors for sensing various attributes or properties of (or relating to) the bathing system **100** and generating corresponding signals representative thereof. The controller **400** may be in operative (e.g., wired or wireless) communication with the sensors and may receive signals generated by the sensors. The controller **400** may perform one or more control algorithms that may change one or more physical properties of the bathing system **100**, and/or may display an output on a display **410**. In some such advantageous aspects, the bathing system **100** may include a display **410**. The display **410** may include a touchscreen to allow a user (e.g., caregiver) to interact with the control system, and/or view outputs or instructions displayed by the control system.

According to an example embodiment, the sensors may include a first sensor **412**. The first sensor **412** may sense a position of a first component of the tub **102** or a second component of the transfer system. For instance, in one embodiment, the first sensor **412** may be a proximity sensor.

Further, in some such cases, the first sensor **412** may be provided on the tub **102**. In such cases, the second component of the transfer system that may be sensed by the first sensor **412** may include a portion of the carrier base **204**. Accordingly, in such embodiments, the first sensor **412** may sense whether the carrier base **204** is within a predetermined distance and generate a first signal **412**S. Alternatively, the first sensor **412** (e.g., proximity sensor) may be provided on the carrier base **204**. In such cases, the first sensor **412** may sense whether the carrier base **204** has been moved to within the predetermined distance. In alternative embodiments, the first sensor **412** may measure a relative position or the distance between a portion of the tub **102** and a portion of the carrier base **204**, and the first signal **412**S may simply correspond to the distance between the portion of the tub **102** and the portion of the carrier base **204**. Still further, the first sensor **412** may measure an absolute position of each of the portion of the tub **102** and the portion of the carrier base **204** and the first signal **412**S may correspond to the measured absolute positions.

In illustrative embodiments, the portion of the tub **102** and the portion of the carrier base **204** may be the tub lock **252** described herein. For instance, in embodiments where the tub **102** includes a latch and the carrier base **204** includes a carrier pin **250**, the first sensor **412** (e.g., a proximity sensor) sense a distance between the carrier pin **250** and the latch and generate the first signal **412**S. In additional embodiments, the first sensor **412** may sense whether the distance between the carrier pin **250** and the latch is less than a threshold distance. In some such embodiments, if the distance between the carrier pin **250** and the latch is less than the threshold distance, the first sensor **412** (e.g., proximity sensor) may generate a first signal **412**S. The threshold distance may be set to any suitable value. For instance, in one embodiment, the threshold distance may be set to zero, which may correspond to the carrier pin **250** being captured in the latch, and the tub lock **252** being in a "locked" state. Such embodiments may facilitate the controller **400** in deciding whether the carrier base **204** is engaged to the tub **102** and is in a docked and/or "ready" state (e.g., for facilitating safe transfer of a patient into or out of the tub **102**).

In certain embodiments described above, the transfer seat **202** may be lockable with respect to the carrier base **204** by at least one lock. For instance, a first lock **300** and a second lock may be provided to lock the transfer seat **202** with respect to the carrier base **204**. In such embodiments, a second sensor **414** may be in operative communication with the first lock **300** and/or the second lock. In one example, the first lock **300** and/or the second lock may be mechanically actuable as described with reference to FIGS. **5** and **6**. In such cases, the second sensor **414** may also be a proximity sensor, and as was the case with the first sensor **412** sense one or more quantities (absolute position, relative position, distance, etc.) and generate a second signal **414**S. In another example, the first lock **300** and/or the second lock may be electronically actuable and may include, for example, an electric circuit and/or a solenoid.

According to some embodiments, the tub **102** may include a tub door **170** that may move between an open position and a closed position. The tub door **170** may be in the open position during transfer of the transfer seat **202** into the tub **102**. In such embodiments, a third sensor **416** may sense physical properties that may facilitate determination of whether the tub door **170** is in the open position or in the closed position. For instance, if the tub door **170** is in the open position, the third sensor **416** may generate a third signal **416**S. If the tub door **170** is in the closed position, the third sensor **416** may generate a fourth signal **418**S. In one example, the third sensor **416** can also be a proximity sensor, and may be provided either on the tub door **170** or elsewhere on the tub **102**, and may detect one or more quantities (absolute position, relative position, distance, etc.) and generate the third or fourth signals. Alternatively, in some embodiments, the tub door **170** and/or portions of the tub **102** may include electric circuitry (e.g., electrical contacts) which may be generate an electric signal when the tub door **170** is closed and another electric signal when the tub door **170** is open. The third sensor **416** may use the electric signals of the electric circuitry of the tub door **170** and generate the third or the fourth signal **418**S. Additionally, an additional proximity sensor may monitor whether the transfer seat has fully transferred into or out of the tub.

According to illustrative embodiments, a fourth sensor **420** may sense a level of liquid in the tub **102** and generate a fifth signal **420**S. Such embodiments may provide a variety of information, such as whether a level of liquid (e.g., water and/or bathing product and/or skin care product and/or hydrotherapy product during use) in the tub **102** is above permissible levels, whether a level of liquid in the tub **102** is sufficient to ensure operation of components of a fluid agitation system **122** (e.g., a whirlpool system or an air spa system) and the like. In further optional embodiments, the fourth sensor may sense whether a maximum liquid capacity reached, thereby conserving liquids and reducing wastage thereof, whether a liquid level is sufficiently high to allow rapid filling from the pre-fill tank while simultaneously leading to reduced splashing and noise, and the like.

In various embodiments, additional or alternative sensors may be provided to sense additional physical properties. For instance, a fifth sensor **422** may sense a level of a cleaning solution (e.g., detergent, disinfectant such as quaternary disinfectant, sanitizer, etc.) in the tub **102** during a cleaning operation. In further exemplary embodiment, a sixth sensor **424** may sense a temperature of a liquid in the tub **102**.

In additional embodiments, the controller may interface with remote control buttons or switches such as a button position near the tub door to enable release of the carrier base to tub lock. The controller may interface with the tub lock to effect electronic release. A similar system may be used to provide a button control of the tub door with a solenoid actuated door lock system.

Control Algorithms

FIG. **17**A illustrates an exemplary control algorithm that may be performed by the controller **400** based on the signals received from the sensors illustrated in FIG. **1**C. In FIG. **17**A, several optional steps are indicated with boxes shown by dotted lines. FIG. **17**A illustrates a first control algorithm regarding transfer via the transfer system. At step **502**, the controller **400** receives the first signal **412**S generated by the first sensor **412**. At step **504**, the controller **400** determines whether the first signal **412**S corresponds to a first state where it is permissible to transfer the transfer seat **202** toward or away from the tub **102** or a second state where it is impermissible to transfer the transfer seat **202** toward or away from the hub. In one example, the first state may correspond to the carrier base **204** being docked to the tub **102**. In another example, the first state may correspond to the carrier pin **250** being captured in the tub lock **252**. In a further example, the second state may correspond to the carrier base **204** being undocked relative to the tub **102**. In a further example, the second state may correspond to the carrier pin **250** being not captured in the tub lock **252**. In a further example, the second state may correspond to the

carrier base **204** being positioned outside the threshold distance relative to the tub **102**.

If the controller **400** determines that the first signal **412**S corresponds to the first state where it is permissible to transfer the transfer seat **202** toward or away from the tub **102**, the controller **400** may generate a first output at step **506**. If the controller **400** determines that it is not permissible to transfer the transfer seat **202** toward or away from the tub **102**, the controller **400** may generate a second output at step **508**.

In some embodiments, the carrier base **204** and the transfer seat **202** may include a first lock **300** and/or a second lock that may include electronic components (e.g., a solenoid). In such embodiments, the first output may be an electric signal that may deactivate the electronic components to automatically release the first lock **300** and/or the second lock, thereby permitting the relative motion between the carrier base **204** and the transfer seat **202**. In such embodiments, the step of determining whether the signal corresponds to a first state where it is permissible to transfer the transfer seat **202** toward or away from the tub **102** prior to unlocking the first lock **300** and/or the second lock may ensure additional safety, and reduce the chances of injury to the patient being transferred.

In additional or alternative embodiments, the first lock **300** and/or the second lock may be manually actuable. In such embodiments, the first output may be in the form of an instruction (e.g., text, picture, audio, video, animation, etc.) that would permit manually unlocking the first lock **300** and/or the second lock. For instance, the first output may be a visual indication (e.g., a green checkmark on the display **410**), which may indicate that the bathing system **100** is in a "ready" state. The first lock **300** and/or the second lock may then be manually released (e.g., by pressing the handle **220** of the transfer seat **202**, by bearing the second locking pin **308** against the spring-biased jaw, etc.) thereby facilitating relative movement between the carrier base **204** and the transfer seat **202**.

In the embodiments where the carrier base **204** and the transfer seat **202** may include a first lock **300** and/or a second lock that may include electronic components (e.g., a solenoid), the second output may be an electric signal that may actuate the electronic components to maintain the first lock **300** and/or the second lock in a locked state, thereby restricting the relative motion between the carrier base **204** and the transfer seat **202**. Such embodiments may permit the transfer of a patient not to occur under conditions that may be unsafe for the patient.

In some embodiments, the first signal **412**S may be directly representative of the tub **102** and the carrier base **204** being docked, and the carrier pin **250** being captured. In such embodiments, the receipt of the first signal **412**S by the controller **400** may be sufficient for the controller **400** to determine that the bathing system **100** is in the first state (transfer of patient permitted). In such embodiments, in the absence of the first signal **412**S, the controller **400** determines that the bathing system **100** is in the second state (transfer of patient restricted). Such embodiments may ensure that the transfer of a patient takes place only when the controller **400** has received the first signal **412**S from the first sensor **412**.

In some optional embodiments where the transfer system includes a first lock **300** and a second lock, as described above, the bathing system **100** may include a second sensor **414** in operative communication with the first lock **300** and/or the second lock. In such cases, the second sensor **414** may generate a second signal **414**S. In such cases, the controller **400** may be in operative communication with the second sensor **414**. Referencing FIG. **17**A, at optional step **510**, the controller **400** may receive the second signal **414**S generated by the second sensor **414**. Upon receipt of the second signal **414**S, the controller **400** may, at step **512**, generate a third output. In some such embodiments, the third output may (similar to the first and/or second outputs) be displayed on the display **410** of the bathing system **100** in the form of instructions (e.g., text, picture, audio, video, animation, etc.) or an electric signal to control one or more of the first lock, and/or the second lock so as to not release.

In certain optional embodiments, the tub **102** may include a tub door **170** that may move between an open position and a closed position. In such cases, the tub door **170** may be in the open position during transfer of the transfer seat **202** into the tub **102**. As mentioned above, in such optional embodiments, a third sensor **416** may be provided to sense whether the tub door **170** is in the open position, and generate a third signal **416**S if the tub door **170** is in the open position. The controller **400** may be in operative communication with the third sensor **416**. Referencing FIG. **17**B, at optional step **514**, the controller **400** may receive the third signal **416**S generated by the third sensor **416**. At step **516**, the controller **400** may generate a fourth output. In certain advantageous embodiments, the fourth output may be displayed on the display **410** of the bathing system **100** in the form of instructions (e.g., text, picture, audio, video, animation, etc.) or an electric signal (e.g., to control one or more of the first lock, and/or the second lock).

In advantageous aspects, the controller **400** may generate a single output that combines one or more of the first, third and fourth outputs. For instance, the first output may represent that the tub **102** and the carrier base **204** have docked. The third output may represent a condition where the first lock of the transfer seat **202** and the carrier base **204** is in an unlocked state. The fourth output may represent a condition where the tub door **170** is open. In addition to, or instead of generating each of the first, third, and fourth outputs, the controller **400** may, in the alternative, generate a single output. The single output may be in the form of instructions (e.g., "Ready to transfer.") In the alternative, single output may be an electric signal, which may, for instance, deactivate the electronic components to automatically release the second lock, thereby permitting the relative motion between the carrier base **204** and the transfer seat **202**. Such embodiments may advantageously provide multiple sensor outputs that may have to be verified by the controller, prior to releasing the transfer seat **202** for transfer, thereby ensuring that transfer of a patient takes place under safe conditions.

Further advantageous embodiments may involve combining the outputs of one or more sensors to determine if there are additional faults associated with the transfer system that may indicate that the transfer system is in a condition not suitable for transfer. If for instance, the first sensor indicates the tub lock **252** is in a closed position (corresponding to a condition where the carrier base may be docked) but an additional proximity sensor indicates that the carrier pin **250** is not detected, the controller may determine from a combination of two (or more) sensor outputs that the tub lock may have been accidently closed. Alternatively, the carrier pin **250** is detected by the first sensor at a location near or within the tub lock, but if an additional sensor indicates that the tub lock is not in a closed position, the controller may determine from a combination of two (or more) sensor outputs that the tub lock may be malfunctioning. The controller may instruct a caregiver to initiate a mechanical or manual inspection to resolve one or more of such fault

conditions. Alternatively, or in addition, the controller may not activate components of the transfer system to be in a state that permits transfer, as will be described further below.

The third sensor **416** may generate a fourth signal **418**S if the tub door **170** is in the closed position. Referring to FIG. **17**C, at optional step **517**, the controller **400** may receive the fourth signal **418**S, and at optional step **518**, the controller **400** may determine, based on the fourth signal **418**S whether the tub **102** is in a state so as to be filled with liquids. For instance, as mentioned previously, the fourth signal **418**S may represent whether the tub door **170** is closed. Accordingly, when the controller **400** determines that the tub door **170** is closed, the controller **400** may, at step **520**, initiate a tub fill operation. In some such advantageous aspects, the tub fill may be initiated by the controller **400** by communicating (e.g., via wired or wireless circuits) with one or more tub fill valves **140** (as seen in FIG. **1**C) that may be in fluid communication with the liquid source **118**. The controller **400** may electronically actuate the one or more tub fill valves **140**, in turn filling the tub **102** with the liquid (e.g., water, and/or bathing product and/or hydrotherapy product, and/or skin care product).

In advantageous aspects, the communication between the controller **400** and one or more tub fill valves **140** may ensure that the tub **102** is not filled (e.g., beyond a predetermined depth, or at all), in the event that the tub door **170** is open. Accordingly, if the controller **400** receives the third signal **416**S from the third sensor **416**, the controller **400** may not actuate the one or more tub fill valves **140**. Alternatively, the controller **400** may deactivate the tub fill valves **140** when the level of liquid in the tub **102** is greater than a predetermined level.

As mentioned previously, in certain optional embodiments, a fourth sensor **420** may sense a level of liquid in the tub **102** and generate a fifth signal **420**S. In such embodiments, referencing FIG. **17**D, optionally, the controller **400** may receive the fifth signal **420**S at step **522** and determine one or more states of the bathing system **100**. For instance, the controller **400** may, at optional step **524**, determine whether a level of liquid in the tub **102** is greater than an overflow limit. If the controller **400** determines the level of liquid exceeds the overflow limit, the controller **400** may, at optional step **526**, shut off the inflow of liquid (e.g., by communicating with the inlet ports). Optionally, the controller may activate (e.g., via a wired or wireless electric signal) a drain **150** or components thereof (e.g., an electronic valve **152** fluidly communicating with the tub **102** and the drain **150**) to drain the liquid in the tub **102** until the level of the liquid in the tub **102** generally equals or is generally less than the overflow limit.

Additionally or alternatively, the controller **400** may receive the fifth signal **420**S and determine, at optional step **528** whether a level of liquid in the tub **102** corresponds to a level where it may be safe to open the tub door **170** without resulting in leakage of liquid from the tub **102**, and if so, actuate electronic controls to automatically open the door at optional step **530**. Alternatively, in such cases, the controller **400** may display an output on the display **410** indicating that the tub door **170** may be safely opened.

In certain optional embodiments, the bathing system **100** may include a fluid agitation system **122** (e.g., a whirlpool system or an air spa system) with one or more nozzles **130**. In such cases, referring back to FIG. **17**C, at optional step **522**, the controller **400** may receive the fifth signal **420**S and determine, at step **532** whether the tub **102** is in a state (e.g., liquid level is sufficiently high) so as to actuate the one or more nozzles **130**, and if so, at optional step **534** actuate the one or more nozzles **130**. Alternatively, if the controller **400** determines that the tub **102** is in a state (e.g., liquid level is not sufficiently high) to not actuate the one or more nozzles **130**, the controller **400** may prevent actuation of the one or more nozzles **130**, or may not actuate the one or more nozzles **130**.

In some such embodiments, the controller **400** may actuate the nozzles **130** directly, e.g., by sending electrical signals to an electric circuitry in operative communication with the nozzle(s). Alternatively, the controller **400** may actuate the nozzles **130** indirectly, e.g., by sending electrical signals to an electric circuitry of another component (e.g., whirlpool pump **132**) in operative communication with the nozzle(s).

Additional or alternative embodiments may involve control of additional or alternative components of the bathing system via the controller. According to an embodiment, the controller may automatically regulate temperature of the liquid. For instance, the controller may be in operative communication with a temperature sensor (thermocouple) to sense the temperature of liquid, and regulate the temperature thereof to be within predefined limits.

According to another aspect, the controller may automatically initiate cleaning and disinfecting operations, for instance, according to predefined programs. The controller may initiate one or more cleaning and/or disinfecting operations, and may dispense appropriate quantities of cleaning solutions and/or disinfectants in the desired concentrations.

FIGS. **18-19** illustrate a bathing system **100** according to additional or alternative embodiments. In some such embodiments, the tub chamber **104** may be raised and/or lowered with respect to a frame **600** that supports the tub chamber **104**. Advantageously, the raising and/or the lowering of the tub **102** may facilitate patient transfer, and/or may be suitable for an immersion hydrotherapy procedure.

FIG. **18** illustrates the tub chamber **104** in the transfer position while FIG. **19** illustrates the tub chamber **104** in the immersed position. In the transfer position, the tub may be at a level suitable for transfer of a patient via a transfer system such as those disclosed herein. The immersed position may be suitable for providing deeper immersion of the patient to facilitate hygiene, hydrotherapy and/or more coverage or dignity for residents. In the immersed position, the tub chamber **104** may be lower near the rear (e.g., near end **620**) than near end (**618**).

As seen in FIGS. **18-19**, the tub chamber **104** may have a slidable coupling with respect to the frame **600** that may permit raising and lowering of the tub chamber **104**. The slidable coupling may include a hinge axis **602** passing through a hinge point **618** about which the tub chamber **104** may be pivoted.

Continuing with FIGS. **18** and **19**, the frame **600** may include a first frame member **612**, a second frame member **614** and a third frame member **616**. The first frame member **612** may extend generally in a longitudinal direction, and may be coupled to the second frame member **614** at a first end **618**. The first frame member **612** may terminate at a second end **620** near the third frame member **616**. The first frame member **612** may also be coupled to the tub chamber **104**. The first frame member **612** may, according to advantageous aspects, have a slidable, rotational or a hinged coupling with the second frame member **614**. The first frame member **612** may also have a non-slidable coupling with the tub chamber **104**.

The first frame member **612** may not be in direct connection to third frame member **616**. The third frame member **616** may provide support to the first frame member **612**. The

third frame member **616**, and additional members may keep the frame from moving laterally to reduce or prevent side loading of a position motor of the tilt mechanism (explained further).

In certain embodiments as illustrated in FIGS. **18** and **19**, the second frame member **614** may be non-slidably coupled to a fourth frame member **617**. The fourth frame member **617** may be connected to a tilt mechanism **630**. In some such embodiments, the tilt mechanism **630** may include a position motor **632** and/or a linear actuator **634**. The tilt mechanism **630** may be actuated to such that the linear actuator **634** may extend, and thereby bear on the first end **620** of the first frame member **612**. As a result of slidable coupling between the first frame member **612** and the second frame member **614** in the vicinity of the first end **618**, and the actuation of the linear actuator **634** may result in the first end **618** of the first frame member **612** being pivoted relative to the second frame member **614**, thereby pivoting the tub chamber **104** in the direction **636**A or in the direction **636**B shown in FIGS. **18** and **19**.

As mentioned previously, the system may include one or more sensors. In one such embodiment, the system may include a tip sensor **638** which may provide an indication of whether the tub chamber **104** is in the raised or lowered position, and if so, the degree to which the tub chamber **104** has been raised or lowered (e.g., in position or angle). The tip sensor **638** may, in certain aspects, be in electrical communication with the tilt mechanism **630** (e.g., with either the position motor **632** or the linear actuator **634**), and may indicate the degree to which the tilt mechanism **630** has been extended or retracted. Alternatively, the tip sensor **638** may be a position encoder provided, for instance, at the second end **620** of the first frame member **612**, and may measure the position or rotational angle of the second end **620** of the first frame member **612** or the position or rotational angle of the third frame member **616**.

In some optional embodiments that include a tilt mechanism **630** and a tip sensor **638**, the controller **400** may control the tipping of the tub chamber **104**. In some such embodiments, the controller **400** may receive signals from the tip sensor **638** to determine whether the tipping of the tub chamber **104** is sufficient, for instance, to a desired tip position or angle. If the controller **400** determines that the tipping of the tub chamber **104** is sufficient, the controller **400** may deactivate the tilt mechanism **630** (e.g., by stopping supply of current to the position motor **632** and/or linear actuator **634**). If the controller **400** determines that the tipping of the tub chamber **104** is insufficient, the controller **400** may activate the tilt mechanism **630** (e.g., by supplying current to the position motor **632** and/or linear actuator **634**) until a desired tip position or angle has been achieved, as indicated by the signals of the tip sensor **638**.

In certain optional embodiments, the tub **102** may include a pre-fill tank **136**, which may store liquids to facilitate a faster fill of the tub chamber **104**. In some such embodiments, the pre-fill and/or filling of the tub chamber **104** may be automated by programming a pre-fill or filling schedule. The program may be executed by the controller **400** to automatically pre-fill, fill and/or drain the tub chamber **104**, for instance at specific times (e.g., pre-fill prior to bathing or hydrotherapy so as to reduce wait times, drain at night to reduce the chances of microbial growth in the tub chamber **104**, drain if temperature drops below a predetermined value, etc.)

Additional or alternative embodiments may provide additional or alternative sensors. In such cases, the controller **400** may receive signals from additional or alternative sensors, and may perform one or more additional or alternative control operations. Such embodiments may improve safety and ease of use of the disclosed bathing systems.

Exemplary embodiments to the bathing system **100** may also include the use of the display **410** to provide a step-by-step instruction of various functions of the bathing system **100** (e.g., docking, transferring, removing the carrier base **204**, and assisting patients during bathing or hydrotherapy procedures, performing cleaning and disinfecting of the tub **102**, performing other preventive maintenance, and the like). In some such cases, the instructions may be based on a standard set of instructions, or may be customized to each patient. Accordingly, the display **410** includes a caregiver interface to receive inputs corresponding to patient details, and may communicate with a computer (controller **400** or an external computer) to retrieve patient-specific bathing or hydrotherapy process. The retrieved process may be displayed on the display **410** as a set of instructions (e.g., text, visual, audio, video or animations) which may be easy to use. Exemplary systems and methods may also permit record keeping of processes and display them as reports to supervisory personnel at long-term care facilities, hospitals, and the like. Such embodiments may be useful in documenting regulatory compliance of such facilities.

A variety of remote monitoring and control functions via networked computers and portable devices may be provided. In such cases, the controller **400** of the bathing system **100** may communicate (e.g., wired or wireless connection over a network) to provide current status (bath in process, cleaning in process, down for maintenance, available), reservoir status (full, empty, filling) and water temperature, maintenance history, and the like. Systems disclosed herein may also allow remote data entry for patient preferences, remote data entry for caregiver list, and data upload/download.

Embodiments disclosed herein provide several advantages, such as resulting in safe transfer, improved monitoring and sensing and automation or control of bathing systems and/or the bathing process.

Various examples have been described. These and other examples are within the scope of the following claims.

The invention claimed is:

1. A bathing system, comprising:

a tub, the tub comprising:

a tub chamber, and

a support surface within the tub chamber;

a transfer system, the transfer system comprising:

a carrier base, and

a transfer seat operatively coupled to the carrier base, the transfer seat being in either a locked position or an unlocked position with respect to the carrier base,

the locked position limiting a relative motion between the transfer seat and the carrier base,

the unlocked position facilitating relative motion between the transfer seat and the carrier base and allowing the transfer seat to transfer into or out of the tub chamber by slidably engaging a portion of the transfer seat with the support surface within the tub chamber;

a plurality of sensors, at least a first sensor of the plurality of sensors being configured to sense a position of a first component of the tub or a second component of the transfer system and to generate one or more signals representative thereof;

a controller in operative communication with each sensor of the plurality of sensors, the controller being configured to receive the one or more signals generated by the first sensor, the controller being configured to:

determine, from the one or more signals, whether the position of the first component of the tub and/or the second component of the transfer system corresponds to a first state where it is permissible to transfer the transfer seat into or out of the tub chamber or to a second state where it is not permissible to transfer the transfer seat into or out of the tub chamber,

if the controller determines that the one or more signals corresponds to the first state, generate a first output,

wherein, the first output includes a first signal for moving the transfer seat from the locked position to the unlocked position; and

if the controller determines that the one or more signals corresponds to the second state, generate a second output,

wherein, the second output includes a second signal for maintaining the transfer seat in the locked position.

2. The bathing system of claim **1**, wherein the first sensor comprises a proximity sensor, the proximity sensor configured to sense whether the transfer system is engaged to the tub.

3. The bathing system of claim **2**, wherein the tub comprises a latch and the carrier base comprises a carrier pin, the proximity sensor being configured to sense a distance between the carrier pin and the latch is less than a threshold distance, and if the distance between the carrier pin and the latch is less than the threshold distance, generate a first signal.

4. The bathing system of claim **3**, wherein the controller is configured to receive the first signal, and upon receipt of the first signal, the controller determines that the first signal correspond to the first state where it is permissible to transfer the transfer seat into or out of the tub chamber.

5. The bathing system of claim **3**, wherein in an absence of the first signal, the controller determines that the absence corresponds to the second state where it is not permissible to transfer the transfer seat into or out of the tub chamber.

6. The bathing system of claim **1**, further comprising a display in operative communication with the controller, the controller being configured to communicate with the display to display the first output and/or the second output.

7. The bathing system of claim **1**, wherein the transfer seat is lockable with respect to the carrier base by at least one lock.

8. The bathing system of claim **7**, wherein the plurality of sensors comprises a second sensor configured to sense whether the at least one lock is in a locked state and generate a second signal.

9. The bathing system of claim **8**, wherein the controller is in operative communication with the second sensor, the controller being configured to receive the second signal generated by the second sensor, wherein, upon receipt of the second signal, the controller is configured to generate a third output.

10. The bathing system of claim **1**, wherein the tub comprises a tub door configured to move between an open position and a closed position, wherein, the tub door is in the open position during transfer of the transfer seat into or out of the tub chamber.

11. The bathing system of claim **10**, wherein plurality of sensors comprises a third sensor configured to:

sense whether the tub door is in the open position, and

generate a third signal.

12. The bathing system of claim **11**, wherein the controller is in operative communication with the third sensor, the controller being configured to receive the third signal generated by the third sensor, wherein, upon receipt of the third signal, the controller is configured to generate a fourth output.

13. The bathing system of claim **12**, wherein the third sensor is configured to generate a fourth signal when the tub door is in the closed position.

14. The bathing system of claim **13**, wherein, the controller is configured to:

determine, based on the fourth signal whether the tub chamber is in a state so as to be filled with liquids,

if the controller determines that the tub chamber is in a state so as to be filled with liquids, initiate a tub fill operation, and

if the controller determines that the tub chamber is in a state not to be filled with liquids, prevent liquids from filling the tub chamber to a level greater than a predetermined level.

15. The bathing system of claim **1**, further comprising, one or more nozzles configured to generate one or more whirlpool jets.

16. The bathing system of claim **15**, wherein the one or more sensors comprises a fourth sensor configured to sense a level of liquid in the tub chamber and generate a fifth signal.

17. The bathing system of claim **16**, wherein the controller is configured to:

receive the fifth signal generated by the fourth sensor,

determine, based on the fifth signal whether the tub is in a state so as to actuate the one or more nozzles,

if the controller determines that the tub is in a state so as to actuate the one or more nozzles, actuate the one or more nozzles,

determine, based on the fifth signal whether the tub is in a state so as to not actuate the one or more nozzles, and

if the controller determines that the tub is in a state so as to not actuate the one or more nozzles, do not actuate the one or more nozzles.

18. The bathing system of claim **1**, wherein the one or more sensors comprises a fifth sensor configured to sense a level of a cleaning solution in the tub chamber during a cleaning operation.

19. The bathing system of claim **1**, wherein the one or more sensors comprises a sixth sensor configured to sense a temperature of a liquid in the tub chamber.

20. A bathing system, comprising:

a tub, the tub comprising:

a tub chamber, and

a tub door, the tub door movable between an open position and a closed position;

a transfer system, the transfer system comprising:

a carrier base being dockable with the tub, the carrier base being in either a docked position or undocked position relative to the tub; and

a transfer seat being operably coupled to the carrier base, the transfer seat being in either a locked position or an unlocked position relative to the carrier base, the transfer seat being movable relative to the carrier base when the transfer seat is in the unlocked position and laterally movable into the tub chamber through the tub door when the tub door is in the open position;

a plurality of sensors, at least a first sensor of the plurality of sensors being configured to sense the docked or undocked position of the carrier base relative to the tub and to generate one or more signals representative thereof;

a controller in operative communication with each sensor of the plurality of sensors, the controller being configured to receive the one or more signals generated by the first sensor, the controller being configured to:

determine, from the one or more signals, whether the carrier base is in the docked position and generate a first output, wherein the first output includes a first signal for moving the transfer seat from the locked position to the unlocked position;

determine, from the one or more signals, whether the carrier base is in the undocked position and generate a second output, wherein the second output includes a second signal for maintaining the transfer seat in the locked position.

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